Industrial QUALITY CONTROL

VOL. V JANUARY, 1949 NO. 4

Officers of ASQC and the Society's Booth at the Third Midwest Quality Control Conference, Chicago, November 4-5, 1948. Left to right: Alfred L. Davis, Treasurer; Simon Collier, Executive Secretary; Wade R. Weaver, Vice President; Ralph E. Wareham, President.

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Industrial Quality Control

VOL. V JANUARY, 1949 No. 4

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Quality Control Stimulates Thinking*

CHARLES D. WIMAN

PRESIDENT, DEERE & COMPANY

The fundamental objective of all companies is to manufacture a product with the highest quality at the lowest cost. If it were possible to ask all production managers within the United States whether they were using Quality Control in their manufacturing operations, most would emphatically answer, YES!

INTUITION AND QUALITY CONTROL

We would have replied the same way four years ago; however, we know today that Quality Control by Statistical Methods is quite different than most manufacturers think. We know that it is possible to take the guesswork out of day-by-day decisions that were previously governed by intuition. I have no fault to find with intuition. As a matter of fact, intuition is generally the combination of long years of practical 'know-how', with a first-hand knowledge of the problem at hand. Decisions based on intuition are generally right, though sometimes risky and hence rather costly.

To digress: I don't suppose that Lou Boudreau ever heard of Quality Control, but he does use intuition. In one of the games at Cleveland a few weeks ago, with two men 'on' and two 'out', he had to decide whether he should put in a pinchhitter or let the regular batter take his turn. The regular batter, for the season, had an average of .335. His composite average for the first five games of the series showed that he was hitting considerably below this figure. He had been 'up' three times that day and had not secured one hit. What would you have done? That is the same type of decision an executive is called upon to make in a varying degree

*Luncheon address presented at the Third Midwest Quality Control Conference, Chicago, November 4, 1948.

several times each month. Lou figured, according to the laws of probability, that his batter **should** make a hit, and he **didn't** put in a pinchhitter. Lou was right. A hit was made and the game was won. If the hit had not been made, could Lou have shrugged his shoulders and said, "According to the laws of probability, and by the use of Quality Control, I could only be wrong three times out of a thousand," or do you suppose he felt, through intuition, that his batter would produce, due to the fact that his average for the year had been high? Lou was using the principles of Quality Control, but probably did not realize it. I am sure that those of you who have studied Quality Control, would have made the same decision that Lou did, namely, leave the batter in, even though the fans clamored for a pinchhitter. Sometimes we, from an executive standpoint, are calling for pinchhitters and make changes that we would not have made had we known about Quality Control. If you don't appreciate the theory behind Quality Control, your decisions may be hesitant and wavering. By chance, you may make the correct decision, but with Quality Control, you will have more confidence that the action you take is sound. **Quality Control stimulates sound thinking.**

Design engineers have for years placed specifications on blueprints. I would not dare say that this was **always** done by intuition, but one of our engineers recently said, "For years we have been using the principles of Quality Control in setting specifications, but we never have had a tool to justify the decisions which the control chart gives us." In short, the control chart, one of the powerful techniques used in Quality Control, tells us whether the specifications on a particular machine should be tightened or made more liberal. Those of you who know the principles of Quality Control realize that if the specifications are WITHIN the 3 sigma control limits, it is impossible for that particular machine to produce a product that will meet those specifications. Rework and scrap will follow. Thus a control chart gives management definite information to use in deciding whether to purchase new equipment. The **reverse** of this can be true and did happen with us. In this case it was proved by a control chart that the old machine could make the parts within control limits, making it unnecessary to purchase new equipment costing $90,000. The point here is: without a Quality Control chart, we did not appreciate the capabilities of the old machine.

I am a firm believer in the slogan, "You Cannot INSPECT Quality Into a Product." Obviously, you cannot improve the quality of a product if it was made wrong in

the first place, yet there are more manufacturers following this practice of post-mortem inspection than the one we are discussing today. For this reason, our entire conception of the responsibilties of an inspection department will be replaced with more 'process inspection' as the years roll by.

INSTALLING QUALITY CONTROL AT DEERE & COMPANY

I gained my first knowledge of Quality Control during the war in the Ordnance Department. While my work was on manpower utilization, I soon found out that whenever Quality Control was applied, two things happened: less personnel was required, and a higher quality product was manufactured at lower cost. Much of the credit for the following accomplishments should be given to General Safford, Chief of Production Service, Office Chief of Ordnance, under whose division this inspection department functioned. During September 1942, the number of ordnance inspectors working through district offices amounted to over 20,000. This was reduced to 13,000 inspectors by April 1943. This fine showing in the utilization of manpower was accomplished in the face of an **increase** of from five hundred million dollars per month of material accepted to one billion five hundred million within this same period.

Do you suppose that when I returned to our company after the war ended I needed any encouragement to recommend Quality Control to our management? It was not difficult to suggest training programs along this line in order to show the value of this new tool, as we had been manufacturing a very large amount of items for the War Department, and our personnel had heard about the various sampling plans used with Quality Control. However, it was not until our managers were trained in the use of average and range charts and we sent personnel from each plant to ten-day courses at leading universities, that we realized the extent of the applications possible. Quality Control stimulated the thinking of our department managers and caused them to analyze more thoroughly their operations by the use of control charts. Whenever any plottings fell outside of control limits for the particular problem, they tried to discover what could be done for improvement. The need for teamwork by the design, manufacturing and inspection departments was apparent from the start.

We developed a training program to appeal to various groups. We held an executive day meeting which was attended by our chairman of the board and your speaker, as well as each one of our vice-presidents in charge of production, sales and accounting. In addition, our design and engineering department managers and the works manager from each of our plants attended. A summation of the experience of other companies and a short instruction period for the use of the various types of charts were given this group, as we felt that unless our executives knew how to interpret a chart and the symbols used, they could not possibly analyze the work being done by others. This was followed by a two-day training course in each plant, which included the works manager, cost accountant, time study, superintendent, design engineer, purchasing department, chief inspector and any others of a supervisory nature who might in various ways benefit by the Quality Control program. At the end of thirty days each manager selected one person to attend a ten-day course at one of the universities. After this individual returned, he gave an in-plant training program for foremen and inspectors. We have trained over eight hundred in the principles of control chart construction since we started our program.

Before commencing Quality Control at each plant we analyzed operations that we had been doing the same way for a great many years. When some of these operations reflected plottings on the outside of the control limits, our Quality Control engineer called this matter to the attention of the various department heads. It wasn't long before the dots were within control limits and other managers requested that Quality Control be installed in their units.

It's the same old story — for a great many years you get along without a new idea or a new process until a subject such as this stimulates the thinking of everyone in the organization. Certain things begin to happen that you can't believe a control chart would bring to pass. Naturally Quality Control cannot be given full credit for all improvement of procedures, because actually the results were due to group action by men in **all** departments. I would say, however, that many of the improvements would not be in existence today if a control chart had not been started.

QUALITY CONTROL GETS RESULTS

This point has been brought home to me on numerous occasions. If past data proved that a certain part was running between eight and ten percent defective and, when the chart was placed before the worker the percentage defective dropped to zero, would you say this was a 'chance' occurrence or an 'assignable cause'? The 'assignable cause' in my opinion was the worker — his pride for good workmanship which he saw reflected in the control chart.

At our Waterloo plant, for example, we have a control chart on over eighty-five percent of our machines. Before these control charts were placed before each operator, the percentage of parts that had to be scrapped or reworked because of inaccuracies ran about five percent. Within three years, this figure has been reduced to 1.1 percent and I am confident that it will be reduced still further. Where we formerly had a large group of men in **rework** departments, today it is possible to assign these men to production.

When supervision takes corrective action on individual jobs that a Quality Control chart shows to be operating out of control or at an unsatisfactory level, we get an improvement in quality of production and in addition, we produce more good pieces. This is the meat of a Quality Control program. Even though parts may be produced within specifications, the control chart shows whether the process is

within 3-sigma limits. This approach has a two-fold result: (1) the operator is sold on the Quality Control program because he has less trouble with the job, and if he is on a piece work basis, it increases his earnings; (2) the company profits by producing more good products in the same number of man hours expended. A better flow of finished unit parts to the assembly line causes less delays or bottlenecks.

It is a proven fact that when a shop produces good material it requires a smaller amount of sorting and inspection. Only Quality Control procedures will give you the exact amount of inspection necessary for a given job. In the early applications of Quality Control your apparent inspection cost may increase, but later on, you will be able to place the inspector on a different kind of inspection. We call it 'patrol inspection.' For example, in one machining department, before Quality Control, we had fourteen inspectors sorting the materials produced because of the high percentage of scrap and rework. After Quality Control and after making corrections on machines and tools, and training the operators, foremen and superintendents in this work, we reduced the number of inspectors to six and the percentage of rejects was reduced from about twelve percent to three percent.

At another point in a large gear cutting department, under old methods, a great deal of delay occurred because of sorting needed to get usable products in sufficient quantities to attain scheduled production. After all individuals in this gear cutting department were trained in Quality Control and charts were installed, the scrap and rework were reduced by over sixty percent and the inspectors reduced by seventy percent.

I have already mentioned the great value placed on a Quality Control chart by one of our design engineers, and I cannot emphasize too strongly, or repeat too often, the necessity of teamwork among the design, engineering and inspection departments. In numerous instances our design engineers now come to the Quality Control engineers BEFORE specification limits are written, not afterwards.

If I did not realize the large reduction in cost which we have had, and we just achieved better cooperation among these departments only, we would still be sold on our Quality Control program.

We are, however, interested in the dollar savings and I could talk for hours on individual savings per machine, but I wish to give you just a few illustrations so that you will better appreciate why our managers are so interested in expanding our Quality Control procedures.

On one machine where we had produced a part for a large number of years, the foreman felt it was impossible to reduce the percentage defective below fifteen percent, or three hundred pieces rejected per day. After placing a Quality Control chart on this operation it was finally possible to rework the die so that its life was increased from six to twelve days. The cost of reworking the die amounted to $150. By increasing the die life an additional six days we saved $25 per day, plus the elimination of all scrap and the cost of reworking three hundred pieces. This gave a total saving per day on this one machine of $43.91. Remember this was on one machine only. At one of our factories, we have over eight hundred and sixty machines equipped with Quality Control charts.

I do not wish to leave the impression that all our factories have a control chart on each machine. Actually, at only one of our plants have we achieved the picture that I have just given you, but we are rapidly approaching that goal, and within the near future we will have made additional progress.

QUALITY CONTROL AND OUTSIDE SUPPLIERS

I wish to stress the importance of Quality Control with our outside suppliers or sub-contractors. The day is not far distant when a manufacturer probably will specify to the vendor that a certified control chart must be submitted with each shipment of material.

One of our vendors was supplying such poor material that we told this manufacturer that at the expiration of the contract we would not accept any further shipments. When the Quality Control charts prepared by our inspection department were shown to the management of this company, they couldn't believe it was possible that such poor material could have been shipped from their plant and asked for assistance in setting up a Quality Control department. Ordinarily we would not have given this assistance, but, as you know, it has been very hard for manufacturers to secure an adequate supply of raw materials and parts, so we agreed. At the end of thirty days, the quality level improved to such an extent that it was superior to the quality of the other manufacturers. When the contract was up for renewal, this concern was given the opportunity of supplying our major requirements. The percentage of rejects of another vendor was running sixteen percent but after Quality Control was applied, within thirty days, the figure had been reduced to two and one half percent and we expect still further improvement.

OTHER QUALITY CONTROL APPLICATIONS

We have also applied Quality Control at our larger sales and branch offices, in office procedures, with some improvement in the quality of the work. When I asked one of our managers recently how he reduced warehouse handling costs fifty percent, he stated, "We accomplished this because Quality Control stimulated our thinking."

A good many operations are performed in more or less of a routine manner over a period of years. If you continually analyze these systems you will find that many reports are still prepared which were formerly of value, but now of little worth — or at any rate — receive little attention.

Quality Control charts of expense accounts, inventories, turn-

over, receivables and sales will give a sales manager a picture that is impossible to secure from hundreds of pages of report tabulations.

One of our sales offices has a Quality Control chart on customer complaints. This brings out a point that cannot be mentioned too frequently. Often, inspection reports in a plant are filed away in a drawer with little corrective action being accorded them. Customer complaints may similarly not receive the attention due them. Even though the complaint was settled to the satisfaction of the customer, the important reason for the complaint was lost — namely, the factory producing the part would like to know more about such matters so that corrections could be made. True, customer complaints could be handled in some other manner, but the point here is that the control chart brings this matter to the attention of those responsible for the quality of the product and action is taken.

Time does not permit me to discuss sales applications, but I am convinced that it is possible for a sales manager to determine through the use of Quality Control techniques whether he is receiving the maximum amount of business in a certain territory at a minimum of sales expense. In the coming buyers' market, can you answer such questions as:

Do you have too many or too few salesmen?

Does more concentration of your sales possibilities justify higher expense?

Are you securing your fair share of the market?

We hope to secure the answers to these questions through the techniques of Quality Control.

CONCLUSION

In closing, I recommend that you present Quality Control to your entire organization slowly. It will take years for a training program to reach all levels of your management and workers so as to become effective. The intangible savings and the teamwork between your departments and the possibility of taking the guesswork out of your day-by-day decisions will well repay your efforts.

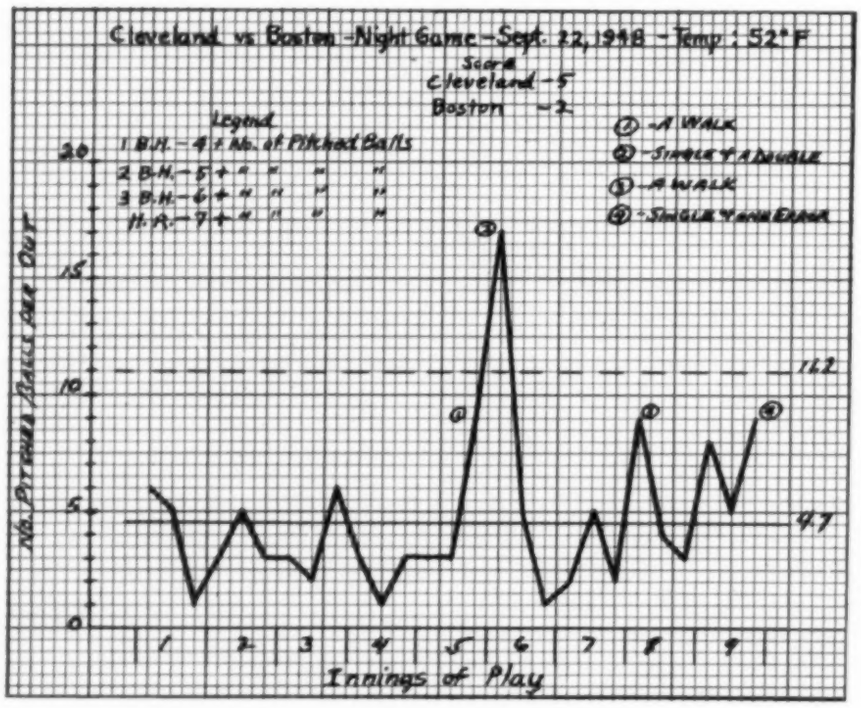
The work of your society and the universities sponsoring Quality Control has been of great value to us. American Industry owes the American Society for Quality Control a tremendous debt. You had the foresight and the willingness to make the effort in the furtherance of this science, thereby helping the United States to continue its leadership in the precision manufacture of quality goods at the right cost.

FOOTNOTE TO MR. WIMAN'S TALK

EDITOR'S NOTE

The accompanying charts were constructed by Mr. Howard C. Dunkel (Fellow, ASQC) of the Republic Steel Corporation, and were submitted to Mr. Wiman by Wade Weaver following the recent Midwest Conference in Chicago. Because they represent a novel and interesting application of control chart analysis, and because of the reference to Lou Boudreau in Mr. Wiman's address, the charts have been made available to Industrial Quality Control as a footnote to Mr. Wiman's paper.

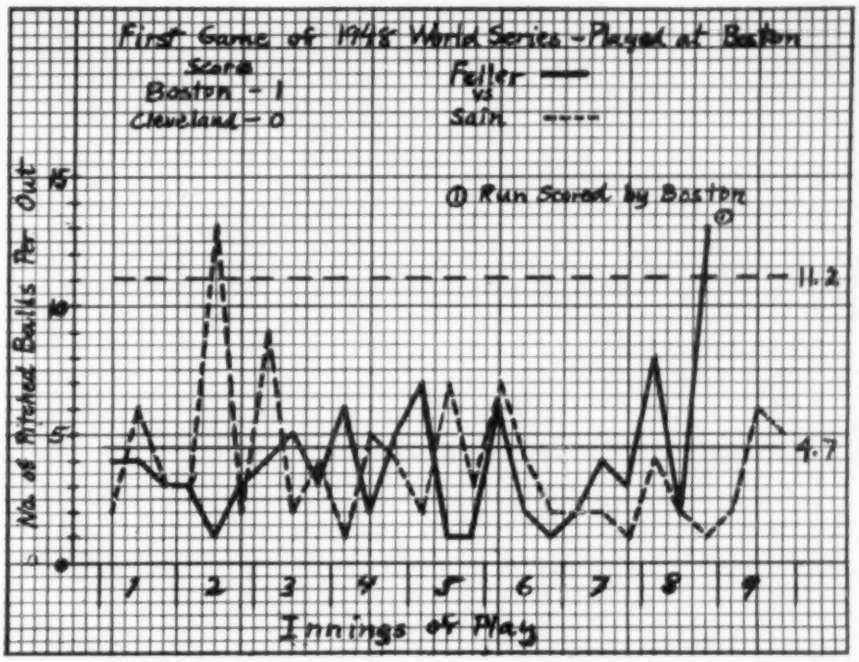
The charts are simple c charts, the "unit of inspection" being an "out," and the number of pitched balls per out being the measure of the pitcher's "quality." The weights assigned to hits allowed are, of course, arbitrary, and weighting scales other than those chosen could be devised. It is, however, rather obvious that some sort of "quality penalty" would be necessary to take account of the failure of a pitcher to retire a side by hitless pitching.


Cleveland vs Boston - Night Game - Sept. 22, 1948 - Temp: 52° F
Score
Cleveland - 5
Boston - 2
Legend
1 B.H. - 4 = No. of Pitched Balls
2 B.H. - 5 + " " " "
3 B.H. - 6 + " " " "
H.R. - 7 + " " " "
① - A WALK
② - SINGLE & A DOUBLE
③ - A WALK
④ - SINGLE & AN ERROR
No. Pitches Balls per Out
20
15
10
5
0
11.2
4.7
1 2 3 4 5 6 7 8 9
Innings of Play

For the September 22nd game, $\bar{c} = 126/27 = 4.7$, and $\sigma = \sqrt{4.7} = 2.17$, whence $UCL_c = 11.2$, and these are taken as standard values for the World Series game recorded on the second chart.

It may seem somewhat amusing to visualize a baseball manager anxiously watching the progress of his pitcher's chart as a game develops! Nevertheless, be it a baseball pitcher or a manufacturing process an appropriate control chart does establish a quality level, a measure of consistency, and a barometer by which impending trouble can be forseen and checked before it has a chance to happen.

Whether or not control charts ever become an operating tool for a team manager, the fact remains that baseball fans among the readers of IQC could find that keeping charts such as these would make an interesting personal hobby that would supply them and their friends with some very revealing information.



The ABC of SQC

A. G. DALTON

SUPERINTENDENT, QUALITY CONTROL, WESTERN ELECTRIC COMPANY, INC.

While riding into work the other day, a neighbor and fellow-commuter sat down next to me and asked me to tell him something about STATISTICAL QUALITY CONTROL. He said that he had seen a few articles in technical magazines but that as soon as he tried to read them he got the idea that they were written by people who knew all about SQC for the benefit of other people who knew all about it. Most of them had curves and charts and talked about distributions and things like that. The thing that impressed him most was that so many of them had one point in common — they all emphasized impressive differences in production costs "Before" and "After"; that is, before and after using SQC.

What my friend wanted to know was how this SQC business worked. Nowadays with costs being what they are, everyone who runs a business has to be on the lookout for new ways of saving a dollar here and there and still keeping his customers satisfied. Apparently, this SQC idea was being used by some of the big companies and had been used by them for years. How could he get to know something about it without taking a course in higher mathematics or statistics?

EDITOR'S NOTE

Those of us who are engaged in quality control work are often asked by our friends and associates, who know nothing about the subject, to tell them what it's all about. Mr. Dalton approaches the subject from the point of view of providing an answer to this question in simple language and with homely examples. Obviously, to be of any use for this purpose, simplicity rather than complete technical accuracy must be the keynote. This material was prepared for inclusion in a publication which the Western Electric Company issues periodically and furnishes to all of its employees.

It seemed to me that the best way to get the ABC of SQC across to my friend was to show him how he had quite likely been applying some of its basic principles — probably quite unconsciously — to many of the things he did day after day. Take catching the train in the morning, for example. He told me that he set his alarm clock one hour before train time and that gave him enough time to get up, shave, get dressed, have breakfast and get to the station. I asked him how often he caught the same train, and he said that he was usually on time, but once in a while something would come up to delay him and he would miss it.

Obviously, my friend had allowed himself an hour because he had found from experience that

when things **went according to schedule** it took him slightly less than 60 minutes. In other words, he probably averaged about 57 minutes. Some mornings things went much better than usual and it took him only 55 minutes (5 minutes he could have stayed in bed). Other days it took him just an hour and he was just able to catch his train. Once in a great while it took him 61 or 62 minutes and then he was just in time to get a nice view of the train as it was pulling out of the station.

The interesting thing is, that when he had quite a few minutes to spare, or when he missed the train, he usually knew just why it was. He could usually put his finger on the very thing that had upset his routine. Since our train of thought is sometimes very rapid, he probably didn't stop to consider the various mental steps he had taken to reach this conclusion. Nevertheless, his thoughts must have followed some of the same general lines that SQC uses to help solve more complicated problems.

In the first place he knew **by experience** about how long it took him on the **average** to get up and dress, how long for breakfast and how long to get to the station. He knew that he could not count on getting the entire job done in exactly the same time every day, because conditions were never exactly the same each morning. So he allowed a margin of about three minutes to take care of **expected differences** from day to day.

There were certain things that usually seemed to tend to slow him up, others to help him get through quicker — things that he had found came up often enough so that he had to allow for them. When these **normal** hindrances outweighed the **normal** helpful influences he began to use up his three minute margin and when the helpful gremlins predominated he had up to three minutes extra to spare. Over a period of time he had learned to expect that these normal helpful influences and hindrances would not result in an overall difference of more than three minutes, one way or the other and, what is more, he relied upon them not to.

When anything follows a close pattern, day after day and year after year, it may be said to be **controlled**, and then we can forecast accurately its behavior tomorrow, or a year from tomorrow, provided the basic causes that affect its behavior do not change. The time of sunrise is an excellent example of something that can be predicted with considerable accuracy. On the other hand, when we have a wide pattern of variation, say the rise and fall of a speculative stock on the market, no reliable close estimate of its price range tomorrow, or a month from tomorrow, can be predicted mathematically because the basic things that affect its behavior are changing all the time.

While my friend could hardly claim that his morning program was controlled as well as the relationship between the sun and the earth, he could class his performance as being more predictable than the price range of a speculative stock. In other words, his performance was pretty well controlled, and he could, therefore, predict with reasonable assurance that if no new or unexpected influences came into the picture he would be able to catch his train each morning if he got up 60 minutes before train time.

Unfortunately, a commuter's life is not as simple as this, and the things which he allowed for and which varied his overall time up to as much as three minutes a day were not the only things that **could** happen. Once in a great while there would be an entirely unexpected delay and unless he was able to adjust himself quickly to the situation he would be late. If this same thing happened not just once in a great while, but two or three times a week, he would have to do one of three things — (A) ignore it and accept the consequences of being late quite often; (B) find out what caused the delay and get rid of it; (C) allow more time each day.

While we leave our commuter friend for a few minutes to work out the answer to this problem, let's see how closely it ties in with SQC in manufacturing. Usually a manufacturer has certain requirements to meet to keep his customers satisfied. He sets up machines, tools and other facilities and hires people to make his product. He does not want to spend more money than necessary by making his product better than it needs to be, nor does he want to lose money by having to scrap or remake a large percentage of his product or lose the confidence and good will of his customers.

He knows from experience, or will soon find out, that however hard he tries to make them all exactly alike there will be minor differences in the size, weight, color, etc., of the things he makes. He need not feel too badly about this, since some of these differences cannot be helped. (The U. S. Mint, for example, cannot produce two pennies **exactly** alike as to size, weight, lettering, etc., but they are, of course, alike enough for every day use. When it comes to hand operations, not even an expert marksman can hit the center of the bull's eye every time). In addition to the differences that cannot be avoided, there may be others due to conditions which can be corrected — some without adding to production costs and others by adding quite a bit to his expenses.

The problem is to strike a nice balance between the **cost** of maintaining better uniformity and the **value** of this better uniformity. The "value" side of the equation may be in terms of substantially fewer items rejected at the completion of manufacture, or a situation where customers will pay enough more for a consistently more uniform product to offset the additional cost, if any, of maintaining this increased uniformity.

It is pretty hard for a manufacturer to arrive at the right answer to a problem of this kind unless he **knows** what amount of variation he is getting among units of his product and unless he also **knows** what part of this variation is due to things he could get rid of without adding to his production costs and what part he cannot get rid of or reduce without increasing his costs.

In order to **know** these things he must set up a systematic plan of inspection and keep records which will show him the extent of the variations between units or batches of product from hour to hour, week to week, or from month to month. These records of inspection results form a very important part of our SQC work, and every effort should be made to see that they are reliable. The inspections may be on a sampling basis, where we do not look at all units of product but only at a portion of them, or they may be detailed inspections where every unit of product is inspected. If only samples are inspected we must do as good a job as we can in looking at samples which represent a good cross-section of the whole output. Furthermore, the units of product that are inspected must be inspected honestly, without fear or favor, and the results must show just what was found and not what the inspector thinks his boss would like to have him report. Over a period of time these inspection results will build up an historical picture of the job.

This, however, is just the beginning. The manufacturer now needs to interpret these results statistically and if he cannot do this himself he had better employ someone who can, because he cannot get the full benefits of SQC without this statistical analysis. It is just like going to a doctor or a dentist for a semi-annual or annual check-up. The doctor compares what he finds on today's examination and what you tell him about yourself, with what you told him and what he found the last time he examined you and the time before that. It is largely on the basis of this comparison that he can tell you if you are holding your own or slipping a bit. However, it takes specialized knowledge and experience to be able to interpret these findings and reports and draw reliable conclusions from them.

In much the same way, proper statistical analysis of inspection results can tell whether a manufacturing process is O.K. or whether it is slipping. The statistical analyst does this by comparing today's inspection results with the results for past periods and seeing how well today's results fit the "pattern" that has been built up by previous results. If this previous history made a pattern which the statistician would call "normal" then any future results which fall within the same pattern can also be called "normal" — even though they may vary somewhat from the objective that is being aimed at. But results that fall outside the pattern are bad, i.e., they indicate that something new has been added which will probably cost the manufacturer money by increasing the number of rejects that have to be repaired or scrapped or which results in customer dissatisfaction until it is removed.

One of the major contributions of SQC is that its techniques permit setting up these pattern boundaries so that we can tell the difference between those variations in quality which are due to normal influences and those which are due to abnormal influences. So long as inspection results fall within the pattern, the manufacturer can save money by using sampling inspections instead of inspecting each unit of product that he makes and, also, he can be reasonably sure that the percentage of rejects he has to scrap or rework is as small as can be expected with his existing manufacturing set-up.

For example, let us assume that a manufacturer takes a realistic view of the situation and, realizing that he can't always hit 100% good product, he sets 98% as his objective. If today's sampling results show 97% good items and 3% rejects, he might well think that 97 is pretty close to 98 and, after all, tomorrow's results may show 98% or even 100% good, and so he does nothing about it. Maybe he's right. Maybe the difference between 97% and 98% is entirely due to those things which may be **expected** to appear in the product, from time to time. However, the next day's results show 96% good and 4% bad. Is this a danger signal? Well, he let the 97% go by without doing anything about it and 96% is pretty close to 97%, so let's let it go for another day and see what happens. One day his inspections show 80% good and 20% bad. Obviously, there is no question when it gets that bad that something must have gone wrong and he must fix it up pretty quickly, since he can't stand the expense of reworking or throwing away 20% of his output. Just where should he draw the line? At 95%? 92%? 90%? SQC techniques take the guesswork out of these decisions and indicate very definitely when he should take action, and he won't waste time and money taking action when he doesn't need to. Obviously the sooner he **knows** rather than **guesses** when his product is "out of control" the sooner he can do some profitable exploring to find out what made it go off the tracks and then do something to get it back into line again. This is an enormous help when something he hadn't figured on begins to affect the product in an early stage of manufacture. If it is not found in time, further material and labor will probably be spent in the later stages of production only to find eventually, maybe in final inspection or tests, that a whole lot of the product must be scrapped or reworked. Or, if he doesn't find it and do something about fixing it up, his customers will tell him about it and he may find that he has to make good on a lot of stuff he's already sold.

Whether SQC pays big dividends or small, in any particular case, will depend on how much there is in the wood or what the maximum possible savings amount to. It will also depend on the cleverness with which inspection control points are set up and the kind of inspection that is set up at each point; the cleverness with which inspection records are analyzed and interpreted, and by no means least, the promptness and vigor with which action is taken when it should be taken. Those who are reluctant to cut down on production while disturbing influences are being identified and removed should bear in mind that by far the cheapest thing to do with unsatisfactory product is not to make it. SQC provides the green, yellow and red traffic lights for production and pays its biggest dividends when these signals are taken seriously.

A New Method for Approving a Machine or Process Setting—Part I

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EDITOR'S NOTE

This is the first of three papers on this general subject. In subsequent issues of IQC, Professor Burr will take up simple sequential methods for a second type of machine checking, and will present a battery of criteria tables providing a variety of possibilities for practical application.

AIM

The purpose of these three papers, of which this is the first, is to present a simple, scientifically sound and economical way to check the setting of a machine or process. Anyone with a reasonable knowledge of control charts can readily learn the methods and can make up tables which an operator or a set-up man can easily use.

EXAMPLE

On a grinding operation the specifications for edge-width are .1840 ± .0005 inches. A control chart for **ranges** has shown that the process is in good control as regards variability, there having been only one point above the upper control limit in 55 samples on the present job and a very similar previous job on the grinder. The average of the ranges for these 55 samples of five pieces each was

$$\bar{R} = .00039''.$$

By the usual method* we estimate the process standard deviation to be

$$\sigma' = \bar{R}/d_2 = (.00039'')/(2.326) = .00017''.$$

*See, for example, *Control Chart Method of Controlling Quality During Production*, Z 1.3, 1942, American Standards Association, 70 East 45th Street, New York 17, New York.

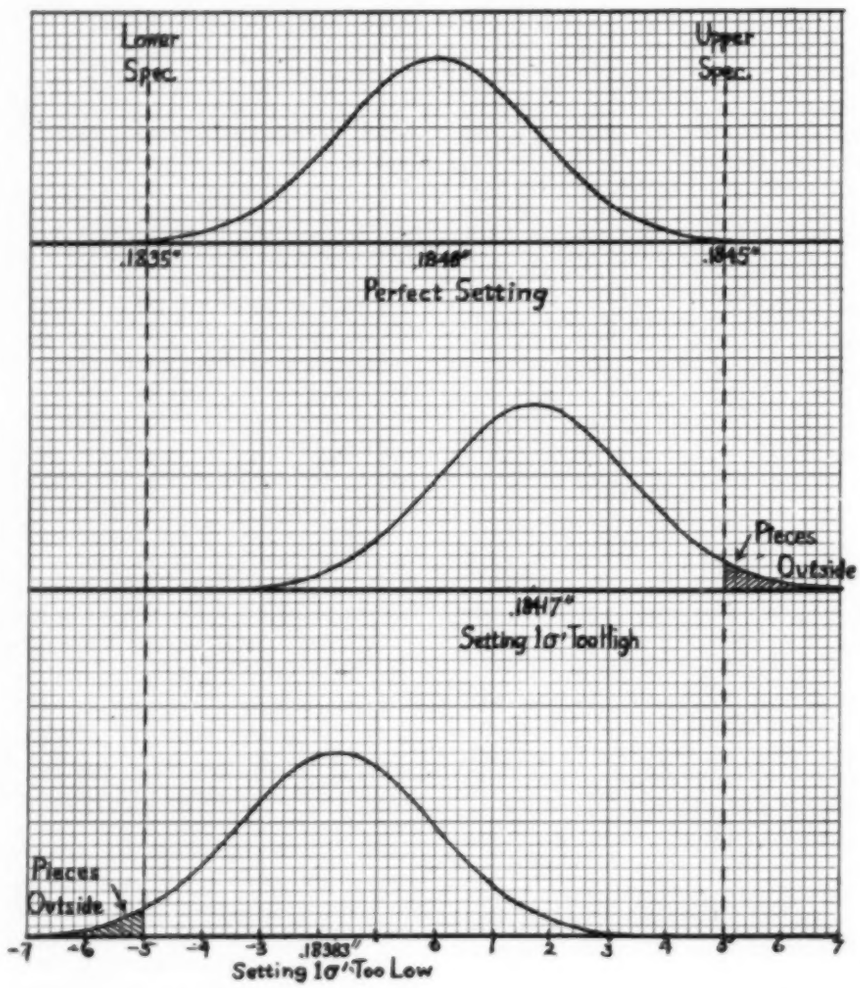

FIGURE 1 — NATURAL TOLERANCE vs SPECIFICATIONS — THREE DIFFERENT SETTINGS

Thus, if the distribution of edge-widths is "normal," we can say that approximately two-thirds of the pieces will have edge-widths within plus or minus .00017" of the process average and that almost none will be as much as 3(.00017"), or .00051", away from the process average. Hence, if by resetting we can keep the process average running close to .1840", we shall be producing essentially no scrap. If, however, the setting were to be off by as much as one σ', that is, by .00017", we shall be producing at least a few out-of-tolerance pieces. This is because a process average of .18417" is less than three standard deviations away from the upper tolerance.

(1) Sample Size n	(2) Approve if Σx is smaller than $L\sigma'$	(3) Number of .0001" from desired .1840". x	(4) Σx, sum of previous column. Watch signs! Σx	(5) Reset in proper direction if Σx is numerically larger than $U\sigma'$
1	—			5.8
2	—			6.6
3	—			7.5
4	—			8.3
5	1.4			9.2
6	2.4			10.1*
7	3.4			10.9
8	4.2			11.7
9	5.1			12.6
10	5.9*			13.4
11	6.8			14.3
12	7.6			15.1
13	8.5			15.9*
14	9.4			16.8
15	10.2			17.7
16	11.1			18.5
17	11.9			19.4
18	12.8			20.2
19	13.6			21.1
20	14.4			21.9

TABLE 1. TABLE FOR CHECKING SETTING WHEN $\sigma' = .00017"$
Departure in Either Direction from Nominal is Undesirable.

*The three starred entries were listed as shown so that it would be clear how to make the decision. Thus the 10.1 entry was really 10.01, which to the nearest tenth is 10.0. But if 10.0 were listed, then there might be some question as to whether a total of 10 were in or out. By listing 10.1 it is clear that a Σx of 10 is not high enough for a rejection. On the other hand, the 15.9 was rounded down from 15.96 so as to indicate that a Σx of 16 justifies rejection. This same convention is followed in making up Table 4.

Hence we should certainly like to reset if the process setting is as low as .18383" or as high as .18417". Figure 1 shows the situation. As may easily be verified by one familiar with a table of the normal curve, there will be approximately 2½% of the pieces above the upper specification of .1845", if the true process average, $\overline{X}'$, is at .18417".

The device we are here describing is designed to control the two main risks with which one is always faced when checking a setting, namely:

(a) resetting the machine or process when it is in reality set just about right;
(b) failing to reset when the setting is in reality too far off from the desired aim.

The risk under (a) has been arbitrarily set at a value of .10. This means that, on the average, only one time in ten will we make the mistake of deciding to reset despite the fact that the setting was right at the desired aim. Secondly, the risk of failing to reset in the case that the setting is off from the desired setting by precisely one standard deviation, σ', is also placed at .10. If, however, the setting is further off than this, then the risk of failing to reset is much less than one time in ten.

In order to be ready to check a setting with the accuracy indicated above, all one needs to do is to multiply each number in Table 3 by the obtained standard deviation, σ', which in our present case was .00017". Thus we make up a table such as Table 1. The signs of the deviations, x, from the nominal as listed in column (3) must be carefully taken account of in building up the total, Σx, in column (4). However, it is only the size of the total in column (4) which counts in the comparison with columns (2) and (5). Thus, if for seven pieces ($n = 7$) we have a Σx larger than $+10.9$ or below -10.9 we reset in the indicated direction. Or if Σx lies anywhere between -3.4 and $+3.4$ we approve the setting. But if the Σx lies between $+3.4$ and $+10.9$ or between -3.4 and -10.9 we take another piece and measure it for the next x, and so on.

Eight illustrations are presented in Table 2 in which a decision was reached after various amounts of sampling. In the first illustration, the first piece measured .1840", or a zero deviation from the nominal. Since approval can only be made after five pieces as a minimum, we need only concern ourselves with possible rejection of setting at this point. The total of zero does not exceed the $U\sigma'$ of 5.8 for an n of 1, so we take another piece. It measures -1 (that is, .1839") so the current total is -1. Since this

Sample Size n	Lσ′	True Setting At: .1840″ (1) x	(1) Σx	(2) x	(2) Σx	(3) x	(3) Σx	(4) x	(4) Σx	.1842″ (5) x	(5) Σx	(6) x	(6) Σx	.1838″ (7) x	(7) Σx	(8) x	(8) Σx	Uσ′
1	—	0	0	−2	−2	+3	+3	−1	− 1	+2	+ 2	+5	+5	−4	− 4	−6	−6	5.8
2	—	−1	−1	+1	−1	0	+3	−2	− 3	−1	+ 1	+4	+9	+1	− 3	Reset		6.6
3	—	−1	−2	0	−1	+2	+5	−1	− 4	+3	+ 4	Reset		0	− 3			7.5
4	—	−2	−4	+3	+2	−1	+4	0	− 4	+3	+ 7			−1	− 4			8.3
5	1.4	−1	−5	0	+2	+2	+6	−1	− 5	0	+ 7			−2	− 6			9.2
6	2.4	+1	−4	−1	+1	+3	+9	−5	−10	+4	+11			−4	−10			10.1
7	3.4	−1	−5	App.		−1	+8	−4	−14	Reset				−3	−13			10.9
8	4.2	+3	−2			−2	+6	Reset						Reset				11.7
9	5.1	App.				+2	+8											12.6
10	5.9					0	+8											13.4
11	6.8					0	+8											14.3
12	7.6					+1	+9											15.1
13	8.5					−3	+6											15.9
14	9.4					App.												16.8
15	10.2																	17.7
16	11.1																	18.5
17	11.9																	19.4
18	12.8																	20.2
19	13.6																	21.1
20	14.4																	21.9

TABLE 2. EXAMPLES OF DECISIONS REACHED USING TABLE 1

Examples (1) — (4) with True Settings at .1840″, (5), (6) at .1842″, and (7), (8) at .1838″.

does not exceed 6.7 in size we measure another piece. It is also a −1, giving Σx as −2. After five pieces the total is −5. Since this is in size between 1.4 and 9.2 we continue sampling. After the eighth piece the total is −2 which is less than the corresponding Lσ′ of 4.3. Hence we approve the setting. Example (3) illustrates a comparatively long run before a decision for approval is reached.

Example (4) illustrates a case in which the wrong decision was reached, namely, reset, even though the setting was perfect at .1840″. In fifty experiments with a perfect setting, this was the only case in which a wrong decision was reached, even though one would expect to have the wrong decision reached in about five cases out of fifty, that is, about 10% of the time. The average number of pieces required before reaching a decision was 7.8 for the fifty experiments in which the setting was correct at 1840″. Hence we can usually expect that a decision will be reached after between five and ten pieces have been checked but that on very rare occasions a decision will not be reached until 18 or 20 pieces have been checked.

Sample Size n	L	U
1	—	3.39
2	—	3.89
3	—	4.39
4	—	4.89
5	.82	5.39
6	1.44	5.89
7	1.98	6.39
8	2.49	6.89
9	2.99	7.39
10	3.50	7.89
11	4.00	8.39
12	4.50	8.89
13	5.00	9.39
14	5.50	9.89
15	6.00	10.39
16	6.50	10.89
17	7.00	11.39
18	7.50	11.89
19	8.00	12.39
20	8.50	12.89

TABLE 3
CONSTANTS FOR CONSTRUCTING A TABLE TO CHECK SETTING

Risks of .10 of Resetting a Perfect Setting and of Failing to Reset When X′ is One σ′ Off.

Examples (5) and (6) illustrate the situation where the setting is somewhat more than one standard deviation above the desired .1840″. After six pieces in example (5) a decision of "reset" was reached since the total of +11 exceeded the Uσ′ of 10.1. In example (6) the decision was reached on only two pieces, +9 exceeding 6.6.

The question would naturally next arise as to how far one should reset. An experiment of fifty such cases as these two indicated that even though a decision may be reached after only one or two pieces are sampled, it is desirable to take four or five and then to reset by an amount approximating the average of the four or five. Thus in case (5) the average of the x's so far is +11, divided by the n of 6, or 1.8, as compared to the correct amount .0002″ (.1842″ − .1840″) by which we should reset. On the other hand in case (6) the average is +9 divided by 2, or 4.5, which is a long way from the 2 units by which the setting is

actually off. Hence in case (6), taking two or three more pieces before actually resetting should give a more reliable indication of the amount to reset. In any case of resetting, it would be desirable to check the new setting at once. In the fifty experiments illustrating the case where actual setting was .1842", there were no cases at all in which a decision for "approve" was reached, all fifty yielding a "reset" decision. The average amount of sampling before reaching a decision was only 5.1 pieces.

Examples (7) and (8) illustrate the situation in which the true setting was .1838". In example (7) a decision was reached after seven pieces because —13 was larger in size than the corresponding $U\sigma'$ of 10.9. The indicated amount to reset is —13 over 7 or 1.9 upward. In example (8) a decision was reached after just one piece. However, if one took the single piece as an accurate indication of the amount to reset, he would reset upward by 6 units and would then be 4 units too far on the high side. Thus again, several pieces should be taken before deciding by how much to reset.

OUTLINE OF PROCEDURE

1. Check on the consistency of variability of the machine or process by running a control chart for ranges, R, or standard deviations, σ, in the usual manner. Each sample should be taken from pieces produced as nearly at the same time as possible. If the control chart shows satisfactory control of variability by twenty-five to thirty consecutive points within the control band or only about one above the upper control limit out of 100 in succession, then approximate the process standard deviation σ' by $\sigma' = \bar{R}/d_2$ or $\sigma' = \bar{\sigma}/c_2$.

2. Multiply each value of L and of U in Table 3 by the σ' just obtained in Section 1. These are listed as $L\sigma'$ and $U\sigma'$ in a table like Table 1. We thus have values telling us when to reset and when to approve the setting.

3. Set gauge or other scale of measurement so as to read from the desired true setting as the zero point. (The value of σ' must have been expressed in the same unit of measurement as that in which the scale reads.)

4. You are now ready to check a setting. Begin taking measurements and recording in the x column as in Table 2, always putting a plus sign (+) if the number is above the desired nominal and a minus sign (—) if below. (Although it would not be strictly necessary to record the plus signs, it is a good plan to get into the habit of always recording a sign so as to force oneself to make note of the direction. In this way one can guard against the error of failing to record any sign when actually a minus sign should be recorded.)

5. As each x is recorded, add it to the previous total, Σx, **taking careful account of the signs** in adding x to the previous Σx.

6. As each Σx is recorded, compare it with $L\sigma'$ and $U\sigma'$.
Take action as follows:

(a) If Σx is positive and above $U\sigma'$, reset downward. The approximate amount by which to reset downward can be found by determining $\bar{x}$ from $(\Sigma x)/n$, but this is not sufficiently reliable unless n is 4 or 5. Hence if a decision to reset is made on fewer than four pieces one should take a few more before finding $\bar{x}$.
(b) If Σx is negative and lies below $-(U\sigma')$, that is, Σx is more strongly negative than minus $U\sigma'$, reset upwards, determining the amount as in (a) above.
(c) If Σx lies between $-L\sigma'$ and $L\sigma'$, that is, if the numerical value of Σx is smaller than $L\sigma'$, approve the setting.
(d) If the numerical value of Σx lies between $L\sigma'$ and $U\sigma'$ take another measurement and check again. If it should happen, as it very rarely may, that no decision is reached on the first 20 pieces, it is here recommended that one reset by an amount equal to $(\Sigma x)/20$, in the appropriate direction, that is, upward if Σx is negative and downward if positive.

Thus we may summarize by saying that if the numerical value of Σx is above $U\sigma'$ we reset in the appropriate direction, or if it is smaller than $L\sigma'$ we approve the setting. On the other hand, if the numerical value of Σx lies between $L\sigma'$ and $U\sigma'$ we continue with another measurement. (Signs must be carefully watched, however, in building up each Σx for use as above.)

AN EXPERIMENT FOR ILLUSTRATION

If, in order to get better acquainted with the method presented, the reader wishes to try a random experiment, the following is recommended. Each "measurement" is a total of four dice. The desired nominal setting is 14. Thus we record in the x column the number of units above or below 14, a total of 19 being an x of +5 and a total of 11 being an x of —3. Now, since for the theoretical distribution of totals of four unbiased dice, we have*

$$\bar{X}' = 14$$
$$\sigma' = 3.42,$$

we shall use 3.42 as σ', calculate values of $L\sigma'$ and $U\sigma'$ from Table 3, and list them as in Table 4. Then, beginning sampling by rolling four dice for each x, we should reach the decision "approve setting" about nine times in ten, because our "process" is really set on the desired nominal of 14.

Next, to illustrate the case in which we should reject the setting nine times in ten, we should like to have a distribution in which

$$\bar{X}' = 14 + 3.42$$
$$= 17.42,$$

that is $\bar{X}'$ is just one σ' too large, and for which

$$\sigma' = 3.42.$$

A distribution of X's which is not too far from these requirements is that for the totals of five dice. The true values are

$$\bar{X}' = 17.50$$
$$\sigma' = 3.82.$$

Thus we take a total of five dice as X, subtract 14, and get an x to record. With such a set of "measurements" we should reach the decision of "reset downward" approximately nine times in ten, although the true proportion is not exactly .9 (because $\bar{X}'$ and σ' are not exactly at the required 17.42 and 3.42 respectively).

*Irving W. Burr, *Quality Control Report No. 12*, Office of Production Research and Development, September 1945.

Table 4 shows a run for the four dice, reaching the decision "approve" after consecutive rolls of 14, 22, 13, 12, 17, 12 and 14. On the other hand the following X's for totals of five dice, which give the values of x (X − 14) as shown, yield a decision to reset downward:

X_i	18	14	22	19

(actual totals of five dice)

x_i	4	0	8	5

(points deviation from 14)

TWO OTHER PLANS FOR CHECKING A SETTING

Although it is believed that the plan shown above will be found satisfactory for most purposes, nevertheless there may be some occasions when a tighter or a looser plan might be desirable. If the total tolerance range is only about $5\sigma'$ in width, then of course there is bound to be some proportion of pieces produced outside of specifications, no matter where the process average $\overline{X}'$ has been set. The only real solution to the difficulty is to make a radical change in the process or, if possible, to widen the specified tolerance band. If neither of these courses of action is economically feasible, then we must do the best we can with what we have. In order to minimize the proportion of defectives it is essential to set as close to the nominal as possible. In such a case the first plan shown below may be used. It has the same 10% risks of wrong decisions, but the .10 risk of failing to reset when we should occurs at $.8\sigma'$ above and below the nominal, rather than at one σ' as before. In order to gain this higher precision of setting, however, a larger amount of sampling is required, on the average. Hence the table is longer.

On the other hand, when the tolerance range is $8\sigma'$ or $9\sigma'$ in width we can afford to be as much as $1.5\sigma'$ off from the nominal, if this does not occur too often. Thus if the tolerance is $8\sigma'$ in width we would be running at $2.5\sigma'$ from one of the specifications (8/2 − 1.5), while in the latter case we would then be $3\sigma'$ away from one specification (9/2 − 1.5). When we can use this plan there will be less inspection on the average than on the standard plan, which of course is the gain through not requiring such a close check on the setting.

Sample Size n	$L\sigma'$	x	Σx	$U\sigma'$
1	—	0	0	11.6
2	—	+8	+8	13.3
3	—	−1	+7	15.1
4	—	−2	+5	16.7
5	2.8	+3	+8	18.4
6	4.9	−2	+6	20.1
7	6.8	0	+6	21.9
8	8.5			23.6
9	10.2			25.3
10	11.9			26.9
11	13.7			28.7
12	15.4			30.4
13	17.1			32.1
14	18.8			33.8
15	20.5			35.5
16	22.2			37.2
17	23.9			38.9
18	25.6			40.7
19	27.4			42.4
20	29.1			44.1

TABLE 4
CONSTANTS FOR ILLUSTRATIVE EXPERIMENT FOR TOTALS OF 4 AND OF 5 DICE
Decision to "Approve" is Shown from Totals of 4 Dice. x is the Dice Total Minus 14.

Table 5 presents the constants for the tighter plan, while Table 6 gives the constants for the looser plan. In the former it is suggested that if no decision is reached in 25 pieces, then a resetting be made by an amount equal to Σx divided by 25. Likewise in the latter case a resetting by $\overline{x}$ or Σx divided by 12 would be made if no deceision is reached in 12 pieces. Fifty experiments gave the average amount of inspection and the maximum n, as shown for cases A, B, and C in Table 7.

TECHNICAL APPENDIX — SEQUENTIAL ANALYSIS, BASIS OF PLANS

All three plans are special cases of sequential analysis for variables as developed by the Statistical Research Group of Columbia University.* In the notation of Section 5 of this book, we have, for the standard case presented first in this paper, the following:

m_1 = nominal or desired level for $\overline{X}'$;

d = largest permissible deviation from m_1,
= σ' (for the first case);

α = risk of rejecting setting, if process average $\overline{X}'$, is at m_1,
= .10 (the assumed value);

β = risk of approving setting if process average $\overline{X}'$, is at $m_1 + d = m_1 + \sigma'$ (or at $m_1 - d = m_1 - \sigma'$),
= .10 (the assumed value);

σ' = the process standard deviation.

Then the test depends upon $\Sigma(X - m_1)$ which we have called Σx since "x" is the notation we have used when measuring from m_1 as the zero point.

First we determine the constants a and b from α and β.

$$a = ln\left(\frac{1-\beta}{\alpha}\right)$$

$$= ln\left(\frac{1-.1}{.1}\right)$$

$$= 2.19722$$

$$b = ln\left(\frac{1-\alpha}{\beta}\right)$$

$$= 2.19722$$

*Sequential Analysis of Statistical Data: Applications, by the Statistical Research Group, Columbia University Press, New York, 1945.

Sample Size n	L	U
1	—	4.01
2	—	4.41
3	—	4.81
4	—	5.21
5	—	5.61
6	—	6.01
7	.37	6.41
8	1.13	6.81
9	1.63	7.21
10	2.08	7.61
11	2.50	8.01
12	2.91	8.41
13	3.31	8.81
14	3.72	9.21
15	4.12	9.61
16	4.52	10.01
17	4.92	10.41
18	5.32	10.81
19	5.72	11.21
20	6.12	11.61
21	6.52	12.01
22	6.92	12.41
23	7.32	12.81
24	7.72	13.21
25	8.12	13.61

TABLE 5
CONSTANTS FOR CONSTRUCTING A TABLE TO CHECK SETTING
Risks of .10 of Resetting a Perfect Setting and of Failing to Reset When $\bar{X}'$ is $.8\sigma'$ Off.

where *ln* — natural logarithm. The equations of the critical curves are given on page 5.08 of the book to which reference has just been made. In our slightly changed notation the equations are

$$ln \cosh \frac{d\left|\Sigma(X-m_1)\right|}{(\sigma')^2} - \frac{nd^2}{2(\sigma')^2} = -b$$

$$ln \cosh \frac{d\left|\Sigma(X-m_1)\right|}{(\sigma')^2} - \frac{nd^2}{2(\sigma')^2} = a.$$

The former may be transformed as follows ($X - m_1 = x$);

$$ln \cosh \frac{d|\Sigma x|}{(\sigma')^2} = \frac{nd^2}{2(\sigma')^2} - b$$

$$\cosh \frac{d|\Sigma x|}{(\sigma')^2} = e^{\frac{nd^2}{2(\sigma')^2} - b}$$

$$\frac{d}{(\sigma')^2}|\Sigma x| = \cosh^{-1}\left(e^{\frac{nd^2}{2(\sigma')^2} - b}\right)$$

$$|\Sigma x| = \frac{(\sigma')^2}{d}\cosh^{-1}\left(e^{\frac{nd^2}{2(\sigma')^2} - b}\right).$$

The critical curves are

$$\Sigma x = \pm \frac{(\sigma')^2}{d}\cosh^{-1}\left(e^{\frac{nd^2}{2(\sigma')^2} - b}\right).$$

We now define the constants L so that the critical curves are

$$\Sigma x = \pm L\sigma'$$

and hence

$$(1)\quad L = \frac{\sigma'}{d}\cosh^{-1}\left(e^{\frac{nd^2}{2(\sigma')^2} - b}\right).$$

In exactly similar manner we have

$$(2)\quad U = \frac{\sigma'}{d}\cosh^{-1}\left(e^{\frac{nd^2}{2(\sigma')^2} + a}\right)$$

since the algebra is the same with $-b$ replaced by a. The above formulas are satisfactory for small values of n but for larger values of n it is much easier to use a transformation in which it is apparent that L and U rapidly approach linearity. It may be shown that

$$\cosh^{-1}e^v = v + ln\,2 - \tfrac{1}{4}e^{-2v} - \tfrac{3}{32}e^{-4v} - \tfrac{5}{96}e^{-6v} - \cdots$$

by successively using

$$\cosh^{-1}w = ln\left(w + \sqrt{w^2 - 1}\right),$$

the expansion for $\sqrt{1 - u}$, and that for $ln\,(1 + s)$. The series is convergent when v is positive and

Sample Size n	L	U
1	—	2.68
2	.22	3.43
3	1.23	4.18
4	1.99	4.93
5	2.75	5.68
6	3.50	6.43
7	4.25	7.18
8	5.00	7.93
9	5.75	8.68
10	6.50	9.43
11	7.25	10.18
12	8.00	10.93

TABLE 6
CONSTANTS FOR CONSTRUCTING A TABLE TO CHECK SETTING
Risks of .10 of Resetting a Perfect Setting and of Failing to Reset When $\bar{X}'$ is $1.5\sigma'$ Off.

hence

$$(3)\quad \begin{aligned} L &= \frac{\sigma'}{d}\left[\left(\frac{nd^2}{2(\sigma')^2} - b\right) + ln\,2 - \tfrac{1}{4}e^{\left(2b - \frac{nd^2}{(\sigma')^2}\right)} - \cdots\right] \\ &= \frac{nd}{2\sigma'} + \frac{\sigma'}{d}(ln\,2 - b) - \frac{\sigma'}{4d}e^{\left(2b - \frac{nd^2}{(\sigma')^2}\right)} - \cdots, \end{aligned}$$

which is convergent if

$$2b - \frac{nd^2}{(\sigma')^2} < 0$$

or if

$$n > \frac{2b(\sigma')^2}{d^2}.$$

Likewise

$$(4)\quad U = \frac{nd}{2\sigma'} + \frac{\sigma'}{d}(ln\,2 + a) - \frac{\sigma}{4d}e^{-2a - \frac{nd^2}{(\sigma')^2}} - \cdots$$

which is convergent for all n's. Now since both a and b are 2.1972 and *ln* 2 is .69315, we have for the respective cases:

TABLE 7. SUMMARY OF 50 EXPERIMENTS FOR EACH OF CASES A, B, AND C.

Case	Setting at	Actual Setting	Decisions		Average Amount of Sampling, $\bar{n}$	Maximum n
			Approve	Reset		
A	$\pm\ \sigma'$	$\bar{X}' = 0$	49	1	7.82	21
		$\bar{X}' = +1.17\sigma'$	0	50	5.10	12
B	$\pm\ .8\sigma'$	$\bar{X}' = 0$	43	7	9.34	27
		$\bar{X}' = +\ .87\sigma'$	4	46	7.36	16
C	$\pm 1.5\sigma'$	$\bar{X}' = 0$	49	1	3.72	10
		$\bar{X}' = +1.46\sigma'$	6	44	3.02	11

CASE A	CASE B	CASE C
$d = \sigma'$	$d = .80\sigma'$	$d = 1.50\sigma'$
$L = \cosh^{-1}\left(e^{\frac{n}{2}} - 2.1972\right)$	$L = 1.25\cosh^{-1}\left(e^{.32n} - 2.1972\right)$	$L = \frac{3}{5}\cosh^{-1}\left(e^{\frac{3n}{8}} - 2.1972\right)$
$= \frac{n}{2} - 1.504 - \frac{1}{4}e^{-4.3944-n} - \ldots$	$= .4n - 1.880 - .31e^{-4.3944-.64n} - \ldots$	$= .75n - 1.003 - \frac{1}{6}e^{-4.3944-\frac{3n}{4}} - \ldots$
$U = \cosh^{-1}\left(e^{\frac{n}{2}} + 2.1972\right)$	$U = 1.25\cosh^{-1}\left(e^{.32n} + 2.1972\right)$	$U = \frac{3}{5}\cosh^{-1}\left(e^{\frac{3n}{8}} + 2.1972\right)$
$= \frac{n}{2} + 2.890 - \frac{1}{4}e^{-4.3944-n}$	$= .4n + 3.613 - .31e^{-4.3944-.64n}$	$= .75n + 1.927 - \frac{1}{6}e^{-4.3944-\frac{3n}{4}} - \ldots$

The second form is used in each case as soon as the third and subsequent terms are negligible.

Management Evaluates Progress in the Quality Control Field*

LEE McCANNE

VICE PRESIDENT AND GENERAL MANAGER, STROMBERG-CARLSON COMPANY

Two hundred and thirty-eight years ago the word "statistics" is said to have appeared in the English language for the first time, in 1710, in W. Hooper's translation of "The Elements of Universal Erudition" by J. F. von Bielfeld. Three years later Bernoulli published his theorem and established the mathematical concept of statistics, the basis of so many techniques now used in quality control. Then came the industrial revolution, bringing the machine, the mill, and the factory into our lives, spreading engines and motors onto the farms, into the kitchens, and basements, on the highways, waterways, and in the air.

In the beginning, these machines and engines were made on the guild plan, with all of the parts personally fabricated and hand fitted as each device was assembled, often by the same man who conceived it. Then necessity was the mother of invention, over one hundred and fifty years ago, when Eli Whitney found he had contracted to deliver 12,000 muskets to the army in an impossibly short time **unless** he could accomplish the unprecedented and revolutionary feat of making all the barrels, stocks, hammers, triggers, sights — yes, even the ramrods — sufficiently alike to be **interchangeable**. That was the birth of the assembly line. That was the origin of mass production. That simple idea was one of the greatest steps ever taken to improve the standard of living of the common man. It was the start of low cost production, to make available to every citizen in the land, at a price he can afford, those other American inventions, the telephone, the radio, the phonograph, motion pictures and television, the railroad, the steamboat, the automobile, the airplane, the electric light, the vacuum cleaner, the washing machine, the deep freeze and household refrigerator, to mention only a few.

The shift to interchangeable parts placed new burdens and a new importance on inspection. Where, up to about a century and a half ago, production inspection had been principally concerned with the suitability of the raw materials and a measure of **per**formance of the finished product, a whole new field suddenly opened up, calling for sorting, gauging, comparing, and various measures of the **con**formance of the component parts. The "Go, No-Go" gauge became familiar and important to everyone in manufacturing industry. More recently, the trend to break complex assemblies down into sub-assemblies has offered new opportunities for inspectors to exercise their ingenuity, especially where certain sub-assembly operations may be carried on simultaneously (or "in parallel", as we electrical men say) but other sub-assembly operations must be performed "in series" in a sequence.

Here and there an inspector, inspection department, or factory began to keep records of the number of parts or products it was accepting or rejecting, sometimes with an additional reference to the kinds of rejects being encountered, and perhaps a conjecture as to the reason for the spoilage. Inspection did not always collect these data. Sometimes we simply sat a worker at a bench and instructed him to accept or reject. And, in those instances where a zealous inspector amassed voluminous data, all too often this paperwork was not worth its cost. Today we would probably know how to do it better, with intelligent pre-determination of sample lots or time intervals for comparison, and intelligent screening of the product in

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like quantities. Progress in quality control begins with the systematic collection of factual data by inspection of the product.

There is a growing literature on the subject of **sampling** as the most economical method of collecting inspection data. I believe there is a general realization by managements — certainly the production and sales departments keep pointing it out — that 100% inspection does not guarantee perfection. It is evident from this brief historical review why the quality control movement usually enters the industrial plant through the inspection department or staff. In our plant, we have a Quality Division to perform the functions of inspection and quality control. This division, like other divisions responsible for sales, or engineering, or manufacturing and purchasing, or finance, or industrial relations and properties, reports to the General Manager. It gets its minimum acceptance standards and specifications from engineering, but after that, the Quality Division is charged with assuring a satisfactory product and contributing to the never-ending program of cost reductions.

It is only about twenty-four years ago that Dr. Shewhart and others showed that a statistical analysis of factual inspection data can lead to process improvements and, more spectacularly, to prevent machines from chewing up good material to produce rejects before it happens. That is quality control in the classical sense, as you in the American Society for Quality Control use the term. It is a new tool for efficient management.

Does management appreciate and value this new tool? I'm sure it does. Even where a manager does not understand how much or how little statistical quality control can accomplish for his plant, either in cost savings or in added customer satisfaction, he is determined and anxious to give it a trial.

It is hard to generalize for all industries and all managements. For one thing, there are some firms who seek perfection but there are others whose policy is to seek cost reduction at the expense of some product imperfections. One of the founders of a radio manufacturing business used to say that unless two percent of his customers were complaining, he knew he was spending too much on his product. In our own case, I believe we would gladly spend up to ten percent more than necessary, if it would assure satisfaction to every customer. One measure of a management's evaluation of quality control is the extent to which it is willing to support these operations budget-wise.

It is no wonder that some managements do not yet understand statistical quality control. There have been other things to distract them, let us hope abnormally so, during the few short years in which quality control men have been getting established in this new field. It is one thing to apply control methods to achieve better mechanical precision; I think most of us in management understand the "lingo" when it is applied to simple physical dimensions. It is another thing to apply limits and quality control methods to chemical precision, electrical precision, optical precision, metal alloy production and the like, and it is my impression that management is still a bit skeptical of the ability of statistical methods to improve quality in these non-mechanical or quasi-mechanical directions. Full confidence may be just as richly deserved, and if so it will come as time passes and worthwhile results emerge. Again, it is well for men in any profession to show restraint and caution, and I well understand why repetitive machine operations can be controlled more reliably than manual operations, but I believe some of you in quality control have been over-conservative with regard to what can be accomplished in manual sub-assembly and assembly operations if training is teamed up with quality control.

In case someone in this new field gets discouraged with slow-moving management, let me point to a temporary situation which now works to your disadvantage, but which I believe will soon change. Engineers like to associate with other engineers, salesmen with other salesmen. Even cost accountants, those strangest of creatures, have their own association or professional society. General managers also like to congregate and when they do, there are some men in the group who came up through sales channels and are well versed in sales problems, others who have been engineers, production managers, purchasing agents, financial men, or who climbed the ladder by way of labor relations. These former specialists, now general managers, contribute the sum total of the knowledge of the group. As far as I know, there are few if any general managers today who have been quality control operators, because the field is so new. But that will come. It will probably start in industries where quality or purity is a predominant characteristic of the product. When it does, your lot and status will improve.

In the meantime, you can do a great deal to win the respect of your management and the cooperation of other departments. I am glad to say that these suggestions are already being followed in our company, but here they are:

1. Keep the management informed by a simple report at periodic intervals

   (a) of important processes or operations that appear out-of-control and

   (b) of "success stories" in saving cost or improving quality. Management seldom wants copies of control charts and data; it is sufficient to call attention to matters they may wish to look into, with a simple interpretation of serious things that occur to you as you analyze the data.

2. Give credit to others, whenever possible, in reporting "success stories." You can afford to be generous, and its wins future cooperation to do so.

3. Report to factory departments the results of your analysis of the data in terms which they can understand and put to use.

4. Take the initiative in offering help to other departments. If you have something to propose, say so, then let them handle it. Don't waste time in jurisdictional disputes.

As a general observation, I would say that management is now satisfied that we **have** a new

tool in statistical quality control; that the collection of the necessary data, its analysis, proposing action, and report writing have now been reduced to a matter of routine; that very worthwhile contributions have already been made in the fields of inspection, tool design, gauge control, specification writing, vendor relations, production methods, and field service; but that there is progress still to be made through cooperation with production engineering, design engineering, employee training, vendor relationships, sales promotion, and service. We are probably getting about half the good that can be had when this new tool is given full use and cooperation.

We are making increasing use of sampling methods which result in less actual inspection than was formerly thought necessary. We have reduced and simplified paperwork through the use of tables and charts. We have developed methods for computing the probabilities of acceptance of lots in which various fractions or percentages are defective, or of process averages. We can compute the expected outgoing quality level both as to its limits and its average. We can compare the quality assurance to be obtained by various inspection methods, and the total inspection required by different plans.

Let me warn that we must be careful, in using control charts, not to expect these devices to have supernatural powers. As the Western Electric Company learned from the well-known Hawthorne experiments, **any** seeming attention paid by management to a group of workers, whether for better or worse, can result in increased output and greater uniformity for a short time. So, too, if quality control charts are placed where production workers see them, we may have a sudden but temporary improvement. This change will bear investigation just as carefully as a sudden change for the worse, if we are ever to make the improvement permanent.

We cannot tolerate the irresponsible attitude that the control chart works in some mysterious way, and that this effect is good enough. The search for assignable causes of variability indicated by excessive variation on the chart requires hard work by competent investigators. It is frequently an engineering task of more than ordinary difficulty. This task cannot be shrugged off, even in a change for the better. The progress of quality control in industry must depend upon sound analysis, not upon "flashy" results or accidental benefits.

The Business of Making a Quality Product*

HERBERT MARCY

VICE PRESIDENT AND ASSISTANT TO THE PRESIDENT, GILLETTE SAFETY RAZOR COMPANY

Other sessions of this Conference take up discussions of the technical aspects of Quality Control. I feel much more qualified to talk to you about what Quality Control **means** to management rather than how it is **achieved**. My interest in the subject is more than proportionate to my technical knowledge. At Gillette, we are vitally concerned with Quality Control. For nearly half a century we have made a quality product, and to the limit of our ability and resources we are going to continue the manufacture of quality products.

To give you an indication of how important quality is in our factory and office in South Boston, I want to read a short statement which hangs by every time clock and at every vantage point throughout our plant and office. It reads as follows:

> "Your security depends on quality. Quality of product has made Gillette the greatest name in shaving and our business the largest of its kind in the world.
>
> "Quality and security — a good job and a steady one — go hand in hand. If we maintain quality so shall we grow and prosper. Should we fail — anywhere along the line — all of us will suffer. It is up to each of us — every man and woman in the organization — to make quality our individual trust and responsibility. Let's do it!"
>
> J. P. Spang, Jr.
> President

This thought is constantly before the eyes of every one of our employees.

Quality Control is summarized very adequately for all fields of manufacturing in eight words — eight very familiar words: "Quality of product is essential to continuing success."

We have all heard those eight words which, let me stress, are more than a fine slogan. Those eight words are a concise statement of necessary fact, and management knows this. Management should be determined that the truth of those words be kept alive.

Management exercises Quality Control beyond the production level — not through the use of gauges, micrometers, and photoelectric cells and control charts, but by jealously guarding the reputation of its products built up through years of continuing effort. It does this through use of a different set of tools; its end product is an intangible thing, and its tools are advertising, merchandising, and selling. With these tools, management builds consumer acceptance of its manufactured product. It creates certain standards by which it hopes the public will accept its products. That is Quality Control, **too**.

For instance, our records indicate that the picture of King C.

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Gillette has been printed 96 **billion** times. His picture has become a symbol throughout the world, a symbol of quality. It would be suicide to make a poorer product and trade on the reputation created by nearly fifty years of quality effort.

Another example: one of the nation's leading retailers of gasoline launched an intensive campaign among its stations for clean, sanitary rest rooms, knowing how important this is to motorists. Every effort was made to have their station operators keep clean rest rooms, yet little if any improvement resulted. Then, management took a bold step. Full-page ads appeared in newspapers in every city where this company's gasoline was sold. These ads told the public that rest rooms in filling stations selling their gasoline were as clean as the "bathroom in your own home." The long and hard-sought-for results took place overnight. No operator of a filling station was going to have a dirty rest room after his management had bragged publicly about the cleanliness of that rest room.

A quality slogan becomes an ideal toward which the worker strives. But we must never forget this important fact: the slogan alone is not enough; the quality must be in the product!

Management, in exercising its Quality Control function, must also be on guard against the spreading of any rumor which might affect its manufactured product; against misunderstanding on the part of the consuming public, which again would affect the acceptance of its product. An outstanding example of this was the problem which confronted the canning industry for so many years.

Years ago, housewives were firm in their belief that food left in an open can would rapidly become injurious, even poisonous. Not until the canning industry was able to dispel this erroneous belief were the large packers able to expand their businesses to the important place they occupy in the food industry today. How was this done? It was a tough one.

Their manufactured product was of high quality. The ingredients which went into those cans were selected after rigid quality control. The containers were the finest that could be made. Yet the housewife was stubborn in her belief that food left in open cans was dangerous. Management attacked the problem in the following way: the medical profession was called in to offer testimony that this belief was not true. Biochemists offered their testimony to the same effect. The actual truth was circulated through grade schools and high schools. Home economists did their part. The cans themselves carried the legend, "Contents will not spoil when left in opened can."

Although that erroneous belief has been nearly dispelled today, there are still some women who think that food left in an open can more than two or three minutes is not good. Management in the canning industry must still be alert to the possibility of a recurrence of this misbelief and must guard against it.

It may come as a surprise, when I tell you that there are some five hundred brands of razor blades made today. If I were to ask you to name some of them, I doubt that any of you could name more than five or six. Because I am so close to it, I could name perhaps fifteen or twenty. I could tell you that, at one time, there was a razor blade called the "Jazz-Bow." The next day, or week, the same blade may have been sold under the name "Zoot-Suit." I give this to you as an example of the type of competition with which a quality product is constantly faced.

Although my technical knowledge of Statistical Quality Control is not as extensive as I would like, there are certain developments which led us at Gillette into a more intelligent and comprehensive study and application.

We noted the almost miraculous accomplishments other companies had reported, and thought we should find out what it was all about.

On further investigation, we were satisfied that there is a lot of common sense in the principles, and so we have dipped our toes gingerly into the pond. Right now, we are about up to our ankles. While we haven't felt the full warmth, we're quite certain the water's fine and the swim will be refreshing.

It has been our policy to start out in one department of our organization and "prove in" the methods before attempting to extend them throughout our plant. We feel that this is the best long-run policy.

I might say of our experiences to date that, although we were prepared for substantial results, it has still been somewhat of a shock — a pleasant one — to realize that sensational improvements in the control of quality at lower cost can be made on a product such as our razors, which we have made for so many years.

In our Screw Machine Department, we have been able to eliminate twenty-five bench inspections, considerably reduce junk and rework, while at the same time getting better quality of output.

From what I have seen of the techniques, I am still surprised that such basically simple methods can so swiftly throw into proper perspective problems that our factory people have wrestled with over long periods. In connection with our Tech razor cap, Statistical Quality Control methods were able to cut the variability of the product in half, after **all** other methods had failed. This means better shaves for you, less waste for us. It appears that our previous methods of **"fact-finding"** did not penetrate deeply enough through the "Opinion" strata and the "Opinonated Fact" level down to the layer of "Indisputable Fact."

As well as I can see the picture without knowing the details of calculating three-sigma limits and the rest of it, you people have a way of providing **new facts** with a capital "F". It is your dispassionate analysis of the machine operator's day-to-day problems, for instance, that shows him how to clear away the misconceptions and delusions which have become part of his thinking. You seem to have here a way of dramatizing the facts so that operators, foremen, inspectors — and even vice presidents — can

at once grasp their significance. That, to my mind, is the salient advantage of your techniques. It resolves dispute between inspectors and operators — and even between departments — because its primary objective is objectiveness. Like management itself, you seek to cut across lines of authority to get down to brass tacks. It seems obvious to me that enlightened management must wholeheartedly agree with the soundness of this kind of attack.

In the last analysis, of course, what counts most with the management is **results.** In that connection, you Quality Control people have an important responsibility in keeping your management posted on the status of your assignments. To become **accomplishments,** results must be understood and appreciated by all levels of management. I am sure that management wants very brief, non-technical, periodic reports, with the emphasis on the dollar results.

Show us the true cost of some of our quality problems, and we'll be more interested in your progress. Above all, be brief and graphic. Management has many problems besides quality, and you are competing for attention with these. If your story is easy to read, it will reach the top of the pile much sooner.

Twenty years ago, I was in the manufacturing end of our business and our attempts at Quality Control were never scientific, by your standards. It is always a source of wonder to me how we did as well as we did.

You use a razor blade once, twice, three or more times, and casually toss it away. That blade which you casually toss away — and I mean a Gillette blade — is subjected to seventy inspections. That fact alone will tell you how highly we value Quality Control. These seventy inspections range to a color inspection for the uniformity of the Blue finish of our blades.

The first test starts thousands of miles away from our South Boston plant. We have metallurgists whose sole job is to visit our suppliers in Sweden, Ohio, Illinois, Pennsylvania — in fact, to every mill from which we receive steel — and see to it that rigid standards are met before our steel is cold rolled. (A great deal of improvement made in the development of strip steel by the Swedes is directly traceable to help which we were able to offer them through the years.)

We have seven other manufacturing plants located in Europe, Canada, and South America. Each month our foreign plants are required to supply us with a certain number of blades made in these plants. These blades received in Boston are subjected to the same tests that our domestically made blades go through; blades made in our South Boston plant are sent to our foreign plants for the same comparative checks.

Uniformity, gentlemen, is a priceless thing. Uniformity is a **must** with us — and by uniformity I mean, of course, uniformity of quality. One blade must be and is very nearly the same as another.

Sometimes this vigilance, this protection of our good name, takes on a humorous aspect.

After one of our recent fight broadcasts, the winner was asked to say a word or two before the mike. In an attempt to ingratiate himself with the sponsor, he overlooked the slight impediment in his speech and really took down the house when he reported to a nation-wide hook-up, "I thuh . . . thuh . . . think, Mr. Duh . . . Duh . . . Dunphy, that those juh . . . juh . . . juh . . . **Gem** blades are the best blades made!" (Of course, we have stoutly maintained that what he really said was "**them**" blades!)

There is still another field in which Quality Control is of utmost importance: where the selling of service is the most important part of the operation. You go to one restaurant as against another not only because of the excellence of the food served, but also because the service you receive in one is better than the service you receive in another.

We may carry the analogy further. For example, the gasoline industry again. Each company guards its own formula for a high-octane gasoline, but to the average consumer one kind of gasoline will make his car go very much like another. Therefore, what management must and does sell is the quality of service rendered to the motorist who drives into the filling station handling **his** particular type of gasoline.

This selling of quality service is international as well. It is not without reason that a great British steamship organization has almost a monopoly in transatlantic passenger service. The same holds true in other fields of transportation. In certain sections of our own country, railroad service is far above that of other sections. In air travel, the United States has an enviable reputation for the quality of its service, even though the planes flying foreign flags are in many cases identical with those flying the American flag. Quality Control has no boundaries. It is not national, but international.

I will go further in my challenge to you experts on Quality Control and quote to you a significant remark made recently in the **Intelligence Digest.** The **Intelligence Digest** is a confidential review of world affairs, in a recent issue of which there is an enlightening article on the economic situation in Great Britain today.

The part that I want to emphasize has to do with the main reasons why it is difficult for the British to find the permanent export markets they so badly need. One of the reasons cited in this **Digest** is the economic growth in American industrial capacity and export ambitions. That statement is qualified by a remark which should give all of us pause. The writer, Kenneth de Courcy, a noted economist, says that the economic growth of American industrial exports is offset by the fact that its exports are of a poor quality. Is that not a startling indictment?

But that is the view taken by another nation on the quality of the goods that we make and sell for export. The writer of that particular piece is a world economic authority and he says that our exporting ambitions are falling short due to, and I quote, "lack of attention to quality in our exports."

You, whose job is the business of making quality products . . . man-

agement, whose job is the merchandising of quality products . . . cannot be complacent. I know that neither you nor management will rest satisfied as long as the possibility exists for even the slightest improvement in the quality of the products we now make and sell.

A Survey of Quality Control and Its Growth in Canada*

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INTRODUCTION

It would be unwise to attempt to discuss the development of Quality Control without considering the relation existing between this development and the general economic condition of industry. One who has had an opportunity to visit industrial organizations engaged in the use of quality control systems will agree that economy is a vital factor in the development of any system designed to improve efficiency.

In Canada, as in other parts of the world, scientific development was stimulated by the exigencies of war. The terrific pressure exerted on industrial production systems and the rapidity with which the rate of production was forced to increase left production management far behind in its effort to maintain control of quality let alone to ensure delivery of quality goods. That is an old story now and needs no further elaboration. It is only necessary to think of the number of times some drastic situation has occasioned the development of scientific techniques or caused the conception of new methods to serve industry. Suffice to say that scientific methods of production control were developed during the war and have not outworn their usefulness for the new era of peacetime production.

When we were in a state of war the concerted effort of every able individual in the country was needed to fulfil the demand and maintain the quality of highly specialized equipment. In the best interests of the country it was necessary to produce goods of high quality, and for that reason the government was obliged to pay the price. Labor swallowed its grievances both voluntarily and through enforced legislation. However, now that our democratic system has been released from the bonds of a war economy, we are faced with the problem of unscrambling labor - management strife and stimulating the flow of materials.

Whatever may be the basic factors influencing the supply-demand ratio, it seems that quality and the consumer suffer whenever this ratio becomes too small and inflexible. Some manufacturers take advantage of this undesirable situation and some are left with no other course. Other industrialists, realizing the folly of making so-called ersatz while the sun shines, are endeavoring to establish and maintain pre-war quality. The important point is that the need to have a standard of quality must exist before methods of maintaining quality are of any use whatever.

In Canda, some organizations are supplying incentive for the development of statistical quality control with an eye to the future. For the most part however the stimulus is carried by the educational institutions and research organizations. For the past four years the University of Toronto has sponsored an evening course in statistical quality control and in 1947 introduced into its undergraduate curriculum in the faculty of engineering a course in industrial statistics and quality control. For the past year or so the Ontario Research Foundation under the guidance of Dr. A. E. R. Westman, head of the Department of Chemistry, has conducted research into the application of statistical methods to industrial problems. This has been made possible by a special grant from the National Research Council of Canada which has established a special committee to co-ordinate the fields of applied statistics and science.

The remainder of this paper will be devoted to examples illustrating some of the work carried on by the Ontario Research Foundation on industrial applications of statistical methods.

MEAT PACKING[1]

In some industries it is difficult to determine the efficiency of a process, partly because of the complexities of the process itself, and partly because of the high rate of production. This situation arises in the canning of meat compounds where cans are filled at the rate of neary two a second. The cans are filled on a volume basis but are subject to a weight specifica-

*Paper presented at the Second Annual Convention of ASQC, Rochester, N. Y., February 17, 1948

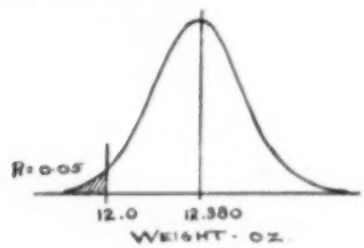
[1]For a more detailed description see article on Process Control in the Meat Packing Industry—Manufacturing and Industrial Engineering, February 1948.

tion which is quoted on the label of the can. One obvious difficulty is that the can may be filled to the limit, or even overfilled, and yet be underweight, so that the density of the compound is a factor which must be considered.

Natural and artificial limitations are imposed upon the three factors volume, weight and density. For example, the size of the can limits the volume; the minimum weight is specified; and the density which must be kept as high as possible is governed by texture and formula specifications and the capabilities of the processing equipment. As an introduction to the study of this problem it is interesting to construct a frequency distribution for weights.

For purposes of discussion we will assume that the specification weight is 12 oz.; the maximum volume of the average can is 340 cc.; and the maximum practical operating density is 1.060 gms. per cc. Since it is impossible to fill all cans with exactly 12 oz. of meat, a certain small percentage underweight is tolerated at, say, 5%.

We will assume that a large number of cans are weighed and the standard deviation is found to be 0.231 oz. Since 5% underweight is tolerated, our mean weight setting is found to be $12 \pm t_1\sigma$ where t_1 corresponds to $p_1 = 0.05$ and is equal to 1.645.[2]



Then $\overline{X} = 12 + (1.645)(0.231)$
$= 12.380$ oz.

If the process can be adjusted to give a mean weight of 12.380 oz. it follows that approximately 5% of the cans will be underweight. Also for any density Y gms. per cc. the filler volume setting may be computed from the following formula:

$$\overline{V} = (28.349)\overline{X}/Y \text{ cc.,}$$

where one ounce = 28.349 grams.

[2]See Normal Probability Tables.

Then for Y = 1.060 gms. per cc.

and $\overline{X} = 12.380$ oz.

$\overline{V} = (12.380)(28.349)/1.060$
$= 331$ cc.

It is conceivable that with the distribution defined by $\overline{X} = 12.380$ oz. and $\sigma = 0.231$ oz. some of the cans will be filled to a greater volume than 340 cc. Such cans are known as "flippers" because of their tendency to have bulged ends, which is a very undesirable condition. The number of flippers may be reduced by increasing the density, but it is not usually possible to exceed 1.060 gms. per cc. The percentage of flippers may be caluculated for a density of 1.060 gms. per cc. by finding the weight beyond which all cans can be expected to be flippers. This weight will be called X_2 and equals

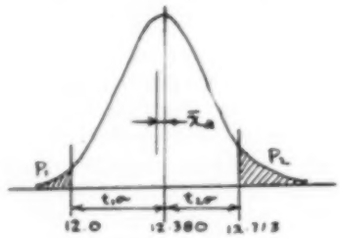
$(340)(1.060)/28.349 = 12.713$ oz.

Therefore

$t_2\sigma = (12.713 - 12.380) = 0.333$ oz.

and $t_2 = (0.333)/(0.231) = 1.44$.

For $t_2 = 1.44$ the corresponding p_2 from Normal Tables is 0.075, so the percentage flippers would not normally drop below 7.5%.



Now assuming that all flippers are removed in the labelling machine before packing, it might be interesting to determine the total amount of overweight meat packed per day for this distribution at a production rate of 100,000 cans per day.

It is first necessary to locate the center of gravity of the area lying under the curve between the limits 12 oz. and 12.713 oz. This is calculated from the formula

$$\overline{x}_a = \frac{\sigma}{A\sqrt{2\pi}}\left[e^{-t_1^2/4} - e^{-t_2^2/4}\right]$$

where $\overline{x}_a$ is the distance from the mean $\overline{X}$ to the center of gravity, A = .875 is the area, e is the exponential constant, and $t_1 = 1.645$ and $t_2 = 1.44$ correspond to $p_1 = 0.05$ and $p_2 = 0.075$ respectively. Substituting from appropriate tables[3], we get

$$\overline{x}_a = \frac{(0.231)(0.103 - 0.141)}{0.875}$$
$$= -0.010.$$

Now the distance of the center of gravity of the area from 12 oz. is $(0.380 - 0.010) = 0.370$ oz., and since this area represents 87,500 cans per day, the amount of overweight meat is

$$(87{,}500)(0.370)/16,$$

or approximately 2000 lbs. of meat per day, an appreciable figure.

This information is usually obtained in a preliminary analysis of the distribution and is important in deciding if a reduction in variation will effect a worth-while saving. In investigations of this type it is necessary to make a list of all possible sources of variation and ultimately to determine the relative significance of the variation contributed by each source. Unfortunately, further discussion of this problem is not possible in this paper.

CONTROL CHARTS FOR DATA HAVING A WITHIN SUBGROUP PATTERN*

Some work has been carried on at the Ontario Research Foundation to develop $\overline{X}$ and R charts for data having a within subgroup pattern. The ordinary control chart assumes that the variation within a subgroup is random and that no definite pattern exists. However, sometimes data will exhibit a definite within-subgroup pattern in addition to the random error.

If we consider a table consisting of data in rows and columns such that there is both a row and column effect and we propose to plot charts for column means and ranges, the row effect would intro-

[3]Tables of the probability functions Vol. II —Federal Works Agency, W.P.A. for the city of New York, 1942.

NOTE: In these tables x is substituted for t.

*Papers developing a full exposition of this important modification of control charts, and giving examples of its application, will appear in the March 1949 issue of IQC.

duce a pattern into the column data. This has the effect of increasing the ranges, and the mean range used in computing the control limits will be so large that the limits will be excessively wide. This condition can be eliminated by subtracting the row means from all the data, computing R and $\overline{R}$ values for the new set of data, and basing the limits for both $\overline{X}$ and R charts on the corrected $\overline{R}$. The corrected $\overline{R}$ must first be adjusted by multiplying by the factor $\sqrt{m/(m-1)}$ where m is the number of columns, to remove any bias that might result by following the above procedure when no pattern is present.

Compensation is sometimes made for the pattern effect by using the 2 sigma limits in place of the 3 sigma limits. However this method is purely empirical.

An example of the above might be found in the steel industry where an analysis is made on the top, middle and bottom of each ingot and it is known that the analyses tend to differ in a systematic way

CONCLUSION

The problems discussed briefly in this paper are typical of those being met and studied in Canadian industry. Interest in this subject is growing in Canada and it is hoped for the future that Canadian manufacturers will continue to become conscious of the methods available to help them solve their production problems.

REPORT OF THE

Third Midwest Quality Control Conference

CHICAGO, ILLINOIS — NOVEMBER 4 AND 5, 1948

The Third Midwest Quality Control Conference is now a matter of record. In point of attendance, special features, and general program it lived up to precedents established by the two preceding conferences and set some new ones for the future. Total attendance for the two days is estimated at better than 1200.

FIRST LUNCHEON SESSION

At the luncheon session on November 4, Mr. Charles D. Wiman, President of Deere & Company, spoke on the subject "Quality Control Stimulates Thinking." His address is published in full elsewhere in this issue of Industrial Quality Control. This luncheon session was sponsored jointly by the nine Midwest Sections of ASQC and the Chicago Association of Commerce and Industry, and was attended by over 800 persons.

SECOND LUNCHEON SESSION

Mr. Hugo A. Weissbrodt, Works Manager, International Harvester Company, Fort Wayne, Indiana, spoke at the second luncheon session on November 5. His subject was "Results Obtained Through Application of Statistical Quality Control," and his remarks were supplemented by an imposing sequence of slides showing the control chart evidence of the improvements claimed. These charts were described and interpreted briefly by Mr. R. D. Long and Mr. Paul Nusbaumer. The testimony supplied by the charts, coupled with the enthusiasm, conviction, and down-to-earth realism put into the presentation by Mr. Weissbrodt left no doubt in the minds of the more than 800 persons who heard him as to the real effectiveness of simple control chart techniques.

CLINICS

The program of clinic sessions arranged for this conference proved to be exceptionally well balanced, diversified, and challenging. The clinics are, of course, the backbone of a conference program, and the topics and speakers available on the 1948 Conference program attracted uniformly high attendance and well deserved praise.

CONFERENCE PAPERS

The 1948 Conference Planning Committee decided against the publication of a separate book of Conference Papers for this conference, feeling that the larger interests of the Society would be better served by making papers on the Conference program available for publication through the medium of Industrial Quality Control. Manuscripts of these papers have been submitted to the Editorial Board for review, and those approved for publication will appear in the Society's journal as rapidly as space permits.

EXECUTIVES' SESSION

One of the special features sponsored by the 1948 Conference was an Executives' Session arranged specifically for the presidents and vice-presidents of companies whose operating personnel is using statistical quality control techniques in various areas of plant operation. The purpose and intent of this session was to present to the top-ranking management of these companies a brief but comprehensive exposition of the reasons why

TRAINING SESSION CLASS — THIRD MIDWEST QUALITY CONTROL CONFERENCE

control chart techniques properly applied and endorsed as company policy can be expected to give the sort of quality improvement and cost-saving results management wants.

The Executives' Session was held on November 5 following Mr. Weissbrodt's luncheon talk, and was attended by 18 presidents and 7 vice-presidents of well-known companies now using statistical quality control techniques. Mr. Frederick J. Halton, Jr. acted as chairman of the meeting. After explaining the purpose of the session, he introduced Mr. Arthur Bender of Delco Remy and Professor Lloyd A. Knowler of the State University of Iowa. These men spoke briefly and to the point on the subject of variation and the control chart as an effective tool for measuring and controlling variation. Following these talks, Mr. Simon Collier showed the Johns-Manville color-sound film "Modern Quality Control."

Dr. Walter A. Shewhart and officers, past and present, of the American Society were invited guests at this session.

The Conference Planning Committee takes pride in having set the precedent of making available to top management an opportunity to meet with men of equal rank from companies using quality control methods, and thus better to acquaint these men with the philosophy and application of the new tool now being used in their respective companies.

TRAINING SESSIONS

Another feature of special importance at this Conference was the two-day training program under the supervision and instruction of Professors Niles H. Barnard and John A. Henry. The photograph accompanying this report shows a portion of the 240 trainees in attendance at these sessions, which were sponsored jointly by the nine Midwest Sections of ASQC and the Chicago Association of Commerce and Industry as a part of its 1948 Business Problems School program. Trainees attending the six sessions of this program received two fundamental types of instruction:

(1) a condensed and lucid **exposition** of control chart and elementary acceptance sampling techniques, and
(2) **practice** under the guidance of a corps of assistant instructors in the actual construction and interpretation of a control chart.

Each trainee was also given a special manual prepared by Professors Barnard and Henry to supplement the course of instruction and to help make permanent for the trainee a record of the basic instruction he received.

The six sessions of this training program may not be the ultimate in education on a mass production basis, but anyone who had the privilege of looking in at any of these sessions could not fail to be

impressed by the magnitude of the undertaking and the intentness with which so large a group of people were cooperating to learn the first basic principles of statistical quality control.

QUALITY CONTROL POSTERS

A third special feature of the Conference which attracted wide attention and added to the general interest was an extensive exhibit of quality control posters covering a wide range of techniques and applications. These posters were assembled by members of the Northeastern Indiana Section from industries in its area and were arranged for viewing in the general assembly area near the main registration desk.

COMMITTEE MEETINGS

The evening of November 4 was left open, and at this time numerous important committee meetings were held. These included not only various committee meetings of the American Society, but also important sectional committee meetings for the nine Midwest Sections. Problems considered and actions taken at many of these meetings will be reported in the American Society News section of this magazine.

EXHIBITS

Eighteen exhibitors played host to a steady stream of interested visitors to the Gage Exhibits during the two days of the conference.

1949 CONFERENCE

The 1949 Midwest Conference will be held in St. Louis, Missouri at a date to be announced later.

Book Review

QUALITY CONTROL — Manual of Practical Procedures for Shop and Plant Operation. Norbert L. Enrick. The Industrial Press, 148 Lafayette St., New York 13, N. Y.; 122 pp.; $3.00. Review by Professor Niles H. Barnard, Chairman, Department of Mechanical Engineering, University of Nebraska.

Even though Statistical Quality Control leans heavily on the application of common sense in industry, it seems quite difficult to write a text that adheres to the common sense approach and yet presents a view that is adequate. Mr. Enrick's book provides an interesting discussion of the subject directed to the working inspector who has neither the time nor the inclination to study the principles of statistical quality control in detail.

An important part of any book is the preface or foreword. Mr. Enrick states very clearly in his foreword that his book is intended for the man in industry who would like to know about statistical quality control and yet feels not quite up to a study of the theory. In following this objective Mr. Enrick takes certain liberties with his subject which may well appear to many as of questionable merit in a book written for beginners. His book would be of only passing interest to anyone who has been studying and practicing SQC for the past few years.

The author opens his presentation with a discussion of various inspection procedures and plans. He gives comparisons of screening, lot-by-lot inspection, and process inspection. In his presentation he seems quite favorably inclined toward the group sequential plan, and develops that method. All of his presentation is given with no attempt to explain why such plans can be used. This is in keeping with the objective of the book as explained in the foreword.

However, one very bad slip occurs at the bottom of page 9 where the statement is made: "If you want to make sure that in the long run no lots containing more than 2% defectives are passed, you have to know:

1. How many sample pieces to inspect in each lot.
2. When to accept the lot.
3. When to reject the lot."

Apparently the author has in mind AOQL protection, but he certainly fails completely to specify correct procedures for securing such protection. It is dangerous doctrine to use, in the name of "simplicity," language as loosely worded as the above quotation in a text aimed at the beginner!

In Chapter 4 Mr. Enrick introduces the reader to the control chart in the installation of Process Inspection. He seems to enter his discussion through the back door by introducing the average range as the measure of "process variability" and using it in a somewhat unconventional form for the establishment of control limits. As one reads on he begins to see some justification for this approach, although it is a little jarring to find continual references to specification lines or limits as base lines from which to measure the distances to determine control limit lines. If one had never studied quality control this could be accepted without argument. In fact, all the presentation thus far is expected to be accepted without argument inasmuch as no attempt is made to prove any statements. They are made by the author based on his experience. The newcomer in the field who is the reader of this book is expected to have faith in the author, and Mr. Enrick writes with that thought in mind.

The newcomer, however, is thereby exposed to concepts and tactics that represent rather radical departures from standard control chart practice. The "simplifications" are of such a nature as to be understandable only to one with considerable sophistication; to the beginner they represent a set of push-button procedures which will almost certainly orient and "set" his thinking in patterns that will require considerable readjustment before he acquires a fundamental grasp of the real meaning and nature of Shewhart control charts.

Chapters 7 and 8 seem to be superfluous even in a book for beginners. Presumably the readers of this book are men who are in the inspection field and therefore should have a good knowledge of such things as gaging, tolerance, and allowance and all that goes with them. Even though the author uses these chapters to lead into Chapter 9, which gives a discussion of the effects of tolerances that are too large or too small and their relation to process variability, it does seem as though Chapters 7 and 8, as written, are somewhat extra.

The presentation of a case history as an illustration was a happy thought, but the reports submitted by the Chief Inspector are quite wordy. Unfortunately the reports used for case study are too much like the style of the text material before and after the reports. Perhaps inspectors are guilty of writing wordy reports, but one wonders if a quality control program could be suggested and then reported in so much rhetoric rather than by tables, charts, and graphs.

One curious defect of this book is its failure to give any discussion of attribute charts. These charts are a "natural" to shop personnel, they have a strong psychological appeal, and they have been immensely useful in helping to create an attitude of quality-mindedness all the way from operators up to top management. They could have been brought in very naturally in connection with the discussion of limit gages in Chapter 8. Oddly enough, three of the four charts in the case history report are **almost** p charts, yet nowhere does the author explain how to make or use either a p, an np, or a c chart.

Again referring to the foreword, we find that the author stated his intention of presenting some of the mathematics of statistical quality control for those who would care to pursue the subject further than it is assumed the average inspector would. Chapters 12 and 13 are used for this purpose. The approach is good and remains simple. Here again, however, not too much effort is used to show why things are and how they come about, but the discussion does make it possible for the more sophisticated reader to discover how the author arrived at some of the unconventional and apparently arbitrary rules given with the exposition in Chapter 4.

This reviewer feels that the author makes a mistake when he attempts to set up his own terminology even though he may use it to create simplicity in his presentation. If his book is successful in making quality control enthusiasts out of his readers they will then want to go on in the study and will change over to the terminology presented in the American Standards Association material. As previously mentioned, there is also some question concerning the value of giving approximate or off-hand methods of solution to quality control problems for immediate simplicity when the reader will probably have much more trouble later on in reconciling the detail with the approximation.

All in all, if one will read the foreword in this book and understand what is in the author's mind in making his presentation, he will find the material easy to read, not too unpalatable, and he may even decide that the book could be helpful in the application of statistical quality control in an organization where it does not now exist. Nevertheless, the conclusion is inescapable that the "practical" man who uses Mr. Enrick's book as his introduction to Quality Control runs a real risk of learning too little too fast!

AMERICAN SOCIETY NEWS

EXECUTIVE COMMITTEE MEETS

The Executive Committe held a highly successful two-day meeting on Friday and Saturday, November 5 and 6 at Chicago following the Third Midwest Quality Control Conference. All but three of the twelve members of the Committee were present.

The Executive Secretary reported that memberships for the 1948-49 Society year were 1396 on November 1, 1948. Of this total, dues had been received from 31 Fellows, 678 Senior Members, and 687 Members. (As of December 8, membership was 1798 of whom 40 were Fellows, 831 Senior Members, and 927 Members).

It was agreed that each Regional Director will follow the Directors in his Region and report at the next meeting what steps have been taken in each Section to secure the highest possible percentage of membership renewals.

The Treasurer presented a report showing a balance on hand of $7,440.23 as of November 1, 1948. A tentative budget of $19,870.00 for the year 1948-49 was adopted. The above figures relate to Society operations and do not include the Shewhart Medal Fund.

The Executive Committee received important reports from the chairmen of Society committees on the work and plans of their committees. Complete and informative reports were presented by the Shewhart Medal Committee, Auditing Committee, 1949 Convention Committee, Committee on Professional Ethics and Qualifications, Committee on Publicity and Public Relations, and the Examining Committee.

There was considerable discussion of the matter of advertising in INDUSTRIAL QUALITY CONTROL. It was pointed out that, with sufficient advertising, the magazine would be self-supporting; however, the cost of printing its journal is still the Society's principal obligation. The President was authorized to strengthen Society organization for obtaining adver-

tising; each Director is urged to take personal steps to obtain ads.

Numerous other matters were given detailed consideration, and action taken in connection with a number of them is recorded elsewhere in this issue of the magazine.

SHEWHART MEDAL

Mr. P. L. Alger, Chairman of the Shewhart Medal Committee, has reported that contributions of $1066 have been received by the Shewhart Medal Fund. Additional amounts have been underwritten so that our goal in establishing the Shewhart Medal is assured.

The committee has announced that individual contributions from Society members will be accepted for a limited time.

Nominations for the 1949 Shewhart Medal Award were open until December 1; the award will be made at our Convention in Boston, May, 1949.

WORK OF THE EXAMINING COMMITTEE

Mr. P. S. Olmstead, Chairman of the Examining Committee, has reported on the work of the Examining Committee since its appointment on September 14, 1947. The Committee, consisting of Messrs. P. S. Olmstead, M. A. Brumbaugh, C. J. Hudson, L. A. Knowler, and W. A. Shewhart, has held four meetings:

9 December 1947 in Princeton;
29 December 1947 in New York;
16 February 1948 in Rochester;
4 November 1948 in Chicago.

Prior to its November 4 meeting, thirty-eight applications for transfer to Fellow had been approved by the Committee. Eighteen Sections of the Society were represented with at least one Fellow.

The Examining Committe has requested that the Board of Directors cooperate in furnishing names and qualifications of individuals who should be considered for Fellowship. Such suggestions should be sent directly to the Executive Secretary of the Society.

SPECIAL SOCIETY COMMITTEES APPOINTED

During the meeting of Section Officers held during the Third Midwest Quality Control Conference, special attention was paid to the importance of close teamwork within the entire ASQC organization. In matters relating to Society information, membership application forms, and membership renewal procedure, further development and coordination are needed.

The President has, therefore, appointed the following committees to prepare recommendations and submit them to the Executive Committee:

Special Committee on Society Information

S. C. Bates, Chairman ..... Ohio
E. C. Bennett ..... California
L. E. Coger ..... Rochester
S. C. Colbeck ..... Pittsburgh
R. H. Magee ..... Dayton
W. J. Masser ..... Philadelphia
J. A. Mitchell ..... Tennessee
A. L. Robertson ..... Washington
B. L. Sander ..... Baltimore
J. Sleith ..... Toronto
R. A. White ..... Rock River Valley

This committee is to review the general information folder and make recommendations as to additions and changes.

Special Committe on Membership Application Forms

S. C. Amren, Chairman ..... Minn.
C. J. Armstrong ..... Illinois
H. J. Becker ..... Chicago
H. R. Bolton ..... Buffalo
J. D. Brooks ..... Tennessee
E. J. Cade ..... N. E. Indiana
D. A. Gensheimer ..... W. Mass.
E. B. Godsey ..... So. Conn.
M F. Goodheart .. Rock River Valley
L. C. Hammond ..... Milwaukee
R. Hilt ..... Boston
J. B. Montgomery ..... Delaware
B. M. Richardson ..... Syracuse
H. I. Santuary ..... Mid-Hudson
J. F. Verigan ..... Ohio

This committee will review the present application forms being used, with the view of designing an application form that can be used by all Sections and the National Office.

Special Committee on Membership Renewal Procedure

Dorian Shainin, Chairman, Hartford
B. Burridge ..... Rock River Valley
C. E. Fisher ..... St. Louis
I. G. Stevenson ..... Southern Tier
J. C. Knapp ..... Michigan
G. W. McDermott ..... Indiana
C. O. McGaughey ..... Iowa
E. G. Newberg ..... Chicago
D. H. Schwartz ..... Metropolitan
G. W. Steiger ..... Ohio
E. Wallace ..... Tennessee
M. J. Wesson ..... Georgia

This committee is to review the present renewal procedure especially with regard to billing forms to be used for Sectional and National dues. The committee will also make recommendations as to the starting date for membership renewal drives and a schedule for follow-up work in each Section.

CINCINNATI SECTION RECOGNIZED

During the summer and fall of 1948, active effort on the part of a number of American Society members in the Cincinnati area resulted in the formation of a local group which applied for recognition as a Section of the American Society.

Such recognition was voted unanimously at the Executive Committee meeting in November, so that the American Society now has thirty-two active Sections.

Mr. M. Rosenblatt of Schenley Laboratories is Chairman of the new Section.

JOHNS-MANVILLE MOVIE

Since its first showing at the Convention in Chicago, June, 1947, the Society has been greatly helped by the presentation of the Johns-Manville color - sound movie on "Modern Quality Control" at many Sectional and Regional meetings. The Officers of our Society have expressed official appreciation to the President of Johns-Manville Corporation for these presentations and for the work of Mr. Simon Collier and Mr. P. B. Proctor of Johns-Manville.

The film has now been shown to 18,721 people in the United States

in the following groups:

	Shows	Attendance
JM Company	40	1676
Associations	38	7075
Schools	11	904
Gov't. Depts.	17	2310
Industries	84	6756
Total	190	18,721

In addition, the film has been shown to some 16,000 persons in India.

Nearly every Section of the Society has had an individual presentation of the film at one of its meetings; all are aware of this unique contribution from Johns-Manville.

NOMINATING COMMITTEE AT WORK

The President has requested the Nominating Committee to begin consideration of nominations for Society officers for 1949-50. It is hoped that information on the nominations will be available in time for publication in the February issue of the NEWS SUPPLEMENT and the March issue of INDUSTRIAL QUAILITY CONTROL.

The members of the Nominating Committee are:

Elwood E. Folsom, Jr., Chairman
George D. Edwards
Ralph A. Hefner
Wyatt H. Lewis
Paul S. Olmstead
Ernest H. Robinson
Herbert G. Winter

As provided in the Constitution, the Nominating Committee consists of the Junior Past President and one Director appointed from each Region.

TENNESSEE SECTION DIRECTOR

Mr. Parker D. Deans has resigned as Director and Chairman of the Tennessee Section and has announced that he is being transferred to the Technical Division of E. I. DuPont de Nemours & Company, effective January 15. Mr. Deans will be located in Richmond, Virginia, and so will be unable to take a direct part in activities of the Tennessee Section.

Mr. Deans' work in the organization of the Tennessee Section is much appreciated by the American Society, and his resignation as Director is accepted with regret. He will continue as a member of the Brumbaugh Award Committee.

Mr. James A. Mitchell of the Tennessee Eastman Corporation has been elected Director and Chairman of the Tennessee Section.

EXECUTIVE COMMITTEE MEETING SCHEDULED

A meeting of the Executive Committee will be held on Wednesday, February 16, in Rochester, New York. The meeting will follow the Fifth Annual Rochester Quality Control Clinic on the preceding day.

ADVANCE NOTICE

THIRD ANNUAL CONVENTION AMERICAN SOCIETY FOR QUALITY CONTROL AND THIRD ANNUAL NEW ENGLAND QUALITY CONTROL CONFERENCE

BOSTON, MASSACHUSETTS

THURSDAY AND FRIDAY, MAY 5 AND 6, 1949

As in two previous years, the New England sections of the American Society for Quality Control are planning a major Quality Control conference in Boston. This year the Hub City will see the Third Annual Convention of the American Society combined with the Regional Conference in a program designed to be both instructive and stimulating to all people interested in quality activities.

While the program as of January 15 is not quite complete, plans include a series-parallel arrangement of clinic sessions to proivde ample opportunity for all to participate, whether their interest is in the more general management phases, in techniques, in specific applications, or in types of industry. In addition there will be outstanding luncheon and dinner programs which will be especially attractive.

The new and different coverage of Quality Control which is planned will be something you cannot well afford to miss.

Mark off May 5 and 6 on your new calendar now, and plan to be in historic Boston for this promising convention.

PLANNING COMMITTEE

W. R. Purcell — Boston Delegate and General Chairman

E. E. Folsom — Regional Director and Advisor

C. D. Ferris — Southern Connecticut Delegate and Chairman of Committee on Program and Speakers

A. MacDougall — Hartford Delegate and Chairman of Committee for Exhibits

J. J. Ferri — Western Massachusetts Delegate and Chairman of Committee on Proceedings

L. A. Seder — Treasurer and Chairman of Finance Committee

M. D. Benedict — Chairman of Committee on Publicity

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AN EXPLANATION

Your January issue of IQC is late in reaching you because, at the scheduled make-up time, it was discovered that important portions of two papers already set had been lost at the printer's, while moving his plant.

Since all of the lost material involved art work, it took time to replace it. Substituting two other papers was not expedient.

This kind of thing can happen to anyone; we are sorry it happened to us!

M.E.W.

NOTICE

As of this issue, mailing list records in the Executive Secretary's office have been reviewed, revised, and brought up to date as nearly correct as available information makes possible.

The name of any member whose dues were not received by the Executive Secretary on or before January 12, 1949, has been removed from the mailing list in accordance with our Constitution. Upon receipt of his dues, he will be reinstated.

The Executive Secretary certainly appreciates the cooperation he has received from the members in notifying him of change of address. Prompt notification to his office of any apparent discrepancies still existing on the Society's official mailing list will be appreciated and promptly adjusted.

If you are not getting your copy of IQC, please send a statement

(1) concerning your dues status and

(2) your correct current address

to

Simon Collier
Executive Secretary, ASQC
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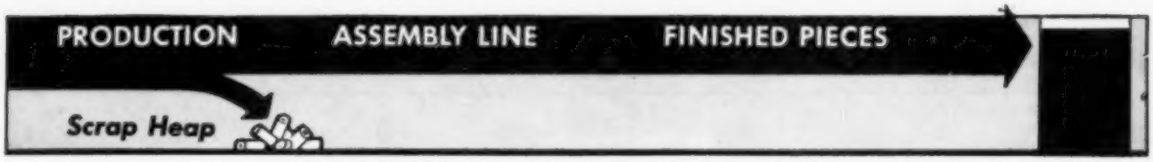

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